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Co-creation and architecture: a participatory approach to studio pedagogy

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**Co-creation and architecture:
a participatory approach to studio pedagogy**

by

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A thesis submitted to the graduate faculty
in partial fulfillment of the requirements for the degree of

MASTER OF ARTS

Major: Industrial Design

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ABSTRACT

As the scope of architectural problems is growing in complexity, new pedagogical models for architecture studio have emerged that introduce new methods and perspectives of information to enrich students' ability to make effective and integrated decisions to prepare them for practice. New approaches to studio pedagogy have focused on providing students with diverse methods and tools intended to generate insights that drive design development and evaluation from perspectives of material innovation, sustainability, and cost analysis. To add to the growing number of pedagogical methods intended to assist student learning of an integrated design process in architecture, this study presents a participatory approach to architecture studio pedagogy that provides students with a cultural awareness of user needs and realistic building constraints to help them more comprehensively design integrated solutions in a studio context. This study documents a structured methodology to facilitate productive participation of diverse stakeholders throughout an integrated architecture studio using generative co-creation as a platform for collaboration.

Co-creation is referred to as any act of collective creativity where multiple stakeholders including designers, researchers and end users collectively engage in design development (Sanders & Stappers, 2008). Co-creation provides an interactive platform for participants to articulate and communicate their explicit, tacit and latent needs to designers and researchers (Sanders, 2002). This study was conducted with a graduate integrated architecture studio at Iowa State University. Over the course of the semester, students led 3 co-creation activities with provided stakeholders (end-users and consultants) centered around their projects. Data was collected with post-activity questionnaires, researcher observation of the activities, semi-structured interviews, and formal interviews. Content analysis was conducted to highlight the key themes related to the effectiveness of co-creation activities in providing meaningful insights

and the overall usefulness of co-creation in engaging end users in the design process. This study evaluates 1) the effectiveness of co-creation activities in providing meaningful insights that drive design development, 2) the role that the medium of co-creation played in facilitating collaboration and gaining insights, and 3) the extent to which insights from co-creation were utilized by students to meet the learning objectives of an integrated design studio. The study provides a methodological approach for integrating co-creation into architecture studio pedagogy.

CHAPTER 1. INTRODUCTION

Background

The purpose of design research is to discover insights that can be used to inspire and inform ideas in the design development process (Sanders, 2008). Design research has taken many forms across the design disciplines. Some have utilized user-centered methods such as contextual inquiry, applied ethnography, evaluative, and usability testing. Others have embraced the participatory design approach to engage future users as co-designers in the design process (Van der Velden & Mörtberg, 2015). Sanders (2008) summarizes the landscape of design research methods that shows evolution of user-centered and participatory centered design methods (Figure 1).

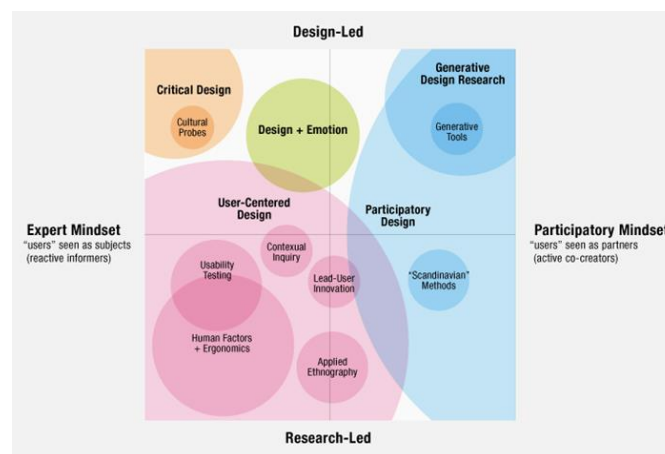


Figure 1. Map of design research-research types (L. Sanders, 2008)

The horizontal axis represents two opposing mindsets in design research – expert mindset and participatory mindset (Sanders, 2008). The designers or researchers conducting research with an “expert mindset” consider themselves as experts and view users as participants, or subjects. The expert mindset creates a strict divide between the users and designers. The expert mindset approach is also known as the user-centered design approach. In contrast, the participatory mindset values people as equal partners in the design process. People are

considered as “true experts” in their domain (Sanders, 2008) and the goal is to provide appropriate tools for people to express and articulate their needs, wants, opinions, feelings and values. Participatory design (PD) is defined as a “design methodology in which the future users of a design participate as co-designers in the design process” (Van der Velden & Mörtberg, 2015, p. 41). Participatory design not only includes future users but other internal and external stakeholders significant to the design project.

The vertical axis represents the drivers of the design process: research-led to design led. The bottom-left quadrant represents the user-centered design approach where researchers use anthropological methods such as interviews, observation and other experimentation methods to conduct contextual inquiries, applied ethnography, human factors research and usability studies. The design-led – expert mindset (top left quadrant) was seen as a reaction to the overwhelming focus on research-led – user centered approach (Sanders, 2008). In this quadrant, designers are considered experts and the goal of research is to provide design inspiration. The bottom-right quadrant represents a “Scandinavian” approach that suggested actively including diverse stakeholders (the future “users”) throughout the design development process. The Scandinavian approach emerged from European labor unions where methods have a political and democratic focus that rely on input from all stakeholders. The top-right quadrant, generative design research, is a design-led approach that utilizes tools and activities for stakeholders to collaborate and actively suggest solutions to design problems. Generative design research, also known as participatory co-creation, provides an interactive medium for users to express and share their feelings, emotions, and values with researchers and designers (Dhadphale, 2017). Participatory co-creation or co-design activities utilize a wide range of tools and techniques such as “collages, maps, physical mock-ups, cultural probes, models made with Lego blocks, models made using

physical shapes that can be connected with Velcro tape, card sorting exercises, game boards and participatory prototypes” (Boradkar & Dhadphale, 2018). Generative co-creation tools are used to prime, probe, and understand participants everyday experiences and provide them an opportunity to generate solutions for current and future problems.

From User-Centered Design to Participatory-Centered Design

Human-centered design research in industrial design. Perhaps the design discipline that embraces each of these research mindsets comprehensively is industrial design (Hanington, 2010). Its value in simultaneously utilizing participatory and user-centered research methods has gained popularity for helping to create products that are more appealing to users. (Thomas & McDonagh, 2013).

There are many design process models utilized by industrial design that uncover users’ functional and emotional needs. The human-centered model created by IDEO is one of the popular models among design researchers. Human-centered design is a creative approach to design that attempts to create user-tailored solutions to problems by integrating users into all stages of the design process. Empathy with users is achieved by generating, evaluating, and refining ideas with users (IDEO, 2013). It has also been described as an “integrated process that includes active consultation with people (users) through various means of primary research during all phases of design development” (Hanington, 2010, p. 21). Utilizing both user-centered methods and generative participatory research methods can offer creative and comprehensive solutions that resonate with user needs (IDEO, 2013). Human-centered design crosses between the bottom-left and upper right quadrants of Sanders’ (2008) map of design research methods.

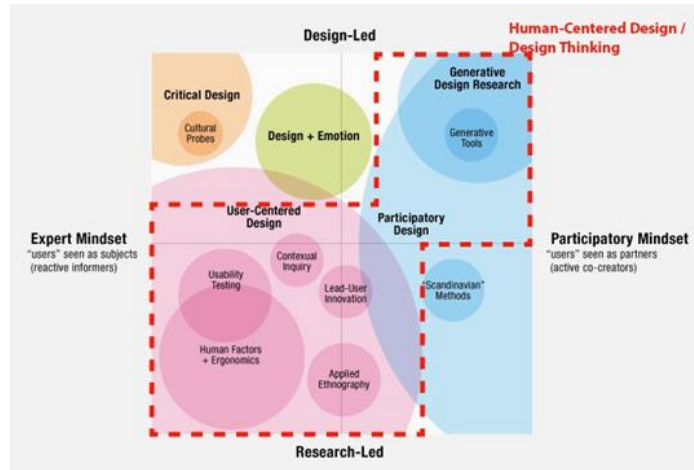


Figure 2. Human-centered design process in the map of design research (Sanders, 2008)

In recent years, there is a growing interest in utilizing both user-centered and participatory centered methods in the discipline of architecture. As the complexity of constraints and problems that architects must react to such as environmental sustainability, more complex urban systems, and culturally diverse communities has increased, architectural education is adapting with new approaches to studio pedagogy to better prepare architects for a changing practice. New studio pedagogies focus on providing students with a diversity of approaches and tools to comprehensively understand problems and provide creative solutions.

Evolving approaches to architecture studio pedagogy. The architecture studio is integral to architectural pedagogy. Studios engage students in different activities of making and conversation, shifting between analytic, synthetic, and evaluative modes of thinking (Dutton, 1987).

Traditional architecture studio pedagogy relies upon the use of “the workshop” and “critiques” from instructors and reviewers. The first quarter of an architecture studio traditionally focuses on studying architectural precedents that have responded to similar problems at different scales of design (Wallick, 2012). Students then practice applying this research within the context of their own studio projects in the beginning phases of the “workshop”. The workshop is a

platform where students learn creative thinking skills by generating and testing ideas to the design brief using a variety of tools such as drawing, making models, and conversing with other students (Brown & Clark, 2013). Throughout the workshop, students learn by presenting their design decisions and gaining feedback from their instructor and architectural reviewers in the form of “critiques”. A discussion of the design challenges of students’ ideas helps them to reframe their design solutions and learn the criteria to assess their own work as they continue to iterate and experiment in studio (Ardington & Drury, 2017). This iterative model of learning utilizes a design-led approach with an expert mindset (See Sanders (2008) model).

As the scope of architectural problems grow in complexity, new pedagogical models for architecture studio have emerged. The new models replicate industry practices by introducing new methods and perspectives of information to enrich students’ ability to make effective and integrated decisions. The advancement of design software such as BIM and sustainability analysis software has provided new tools for students to make informed decisions about integrating complex and effective building systems. Digital advancements have also yielded new pedagogical approaches to studio that focus on digital fabrication of new materials and construction methods (Riether & Wit, 2015). Use of these methods in studios have expanded architecture studio pedagogy into the research-led expert mindset (See Sanders (2008) model).

Design-build is another approach to studio pedagogy gaining popularity because of its value in teaching students how to construct buildings and react to realistic constraints. Students often interact with members of the community and other design stakeholders such as contractors and design consultants. Design build studios encourage collaboration amongst students, help them to understand material opportunities and constraints, and learn how to react to site and context restraints such as community needs (Canizaro, 2012). One of the more comprehensive

pedagogies, design-build studios have expanded architecture studio pedagogy into the participatory design realm of design research. These new approaches to architecture studio pedagogy aim to provide students with new tools and perspectives to help them comprehensively design buildings.

Research Problem

While new models for architecture studio pedagogy emerge, the intent of these new approaches is similar; to help students meet the learning objectives of integrated architectural design. According to the standards set by the National Architecture Accrediting Board (2014) for a student to meet the learning objectives of an integrated architecture studio, students must:

1. Critically integrate research-based intellectual rigor in design development and analysis activities
2. Display an integrated evaluation and decision-making process across multiple scales simultaneously through problem identification, setting evaluative design criteria, analyzing solutions, and predicting effectiveness of implementation
3. Critically integrate a broad range of technical requirements and building systems that support and enhance choices for building performance and experience with consideration of environmental stewardship, technical documentation, accessibility, site conditions, life safety, environmental systems, structural systems, and building envelope systems and assemblies.

New approaches to studio pedagogy have focused on providing students with an alternative lens to help them meet the learning objectives listed above. They give students exposure to new forms of inspiration and methods of analysis from which to base integrated design decisions off. Design-build studios serve as an example of a participatory approach to

studio pedagogy to help students gain information from end users and professionals. Despite the values of this participatory approach, there are few studies that have documented the use of specific participatory methods such as co-creation in the context of an architecture studio.

This study aims to identify how generative co-creation methods can be implemented into architecture studio pedagogy. It serves as documentation of a pedagogical example of a co-creation methodology used to help students address the goals of an integrated architecture studio project. This study will address the following research questions:

1. What is the role of co-creation in gaining insights for an architecture design project?
2. What role did the medium of co-creation play in gaining insights?
3. How did the designers utilize and implement insights gained from co-creation?

Justification for Research

While examples of participatory approaches exist in architecture studio models, studies share little detail of the interactions between external stakeholders and students during the process. The extent to which most studies document these interactions is that they happen in an interview or critique context (Canizaro, 2012). Without a provided structure of when and how to integrate stakeholder perspectives into an architecture studio, it may be difficult for students to gain valuable information from their participation.

Traditional user-centered research methods like interviews and observations focus on understanding the explicit and observable physical user needs. While the understanding of these needs is important, they do not yield information about the deeper psychological needs of users

that may reveal more accurately what they need and want. Researchers have argued that understanding the deeper psychological needs of users requires utilizing participatory research methods like co-creation that provide insights into the tacit and latent (values) aspects of human experience (Dhadphale, 2017; Sanders, 1992). Participatory co-creation provides a platform for

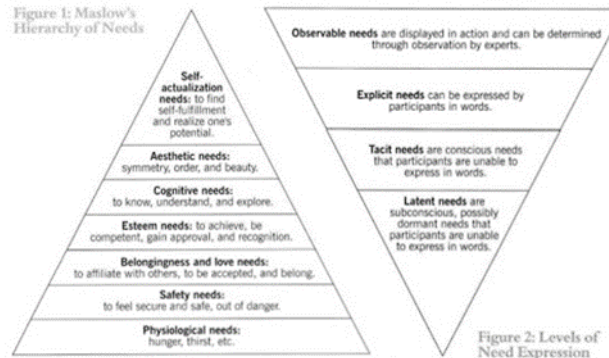


Figure 3. Types of needs compared with Maslow's Hierarchy of Needs (Sanders, 1992)

designers and researchers to uncover the tacit and latent needs of users. Methods such as card sorting, projective expression collages, Velcro modeling and others hands-on activities provide a medium for users to articulate their latent and tacit needs. For these activities to be successful, the designer must lead the participants through an activity by providing them with tools and ways of expressing themselves without requiring artistic skill (Sanders, 1992). These activities are a way of understanding user's feelings, values, and dreams (L. Sanders & Stappers, 2014).

A structured set of student-led co-creation activities could facilitate more productive interactions between students and diverse stakeholders in participatory studio settings to help students gain a more comprehensive understanding of user needs and solutions that aren't immediately evident when stakeholders are consulted verbally. This study provides examples of how and when co-creation activities can be implemented during the process of an architecture studio to help make stakeholder participation more effective and helpful for students in meeting the goals of comprehensive studios.

Students first led users of museums, participants representing guests or employees, in a co-creation activity. Users modeled and arranged spaces and circulation paths, and then matched semantic adjectives and images within those spaces. Users used props such as cardboard shapes, post-its, drawings, Playdough, inspiration images, and markers to create and elicit their ideal

functional and atmospheric qualities of museums. Insights were used by students to develop design criteria, that informed initial schematic designs.

Using their schematic designs as subject matter, the students led another co-creation activity with design consultants later in the semester (week 9). Consultants included interior designers and engineers. Given information about design criteria and goals, the consultants co-created with the students to help them develop their schematic plans and achieve their design goals by providing insight into technical solutions such as materiality, structure and HVAC. Consultants generated feedback using props such as chipboard plans, markers, post-its, Playdough, material and color swatches, and drawing.

Towards the end of the semester (week 13), the students led a final co-creation activity with museum users, participants representing guests and employees, and museum curators to refine their projects. Centered around presentation drawings such as plans, sections, and renderings, users and curators provided verification and refinement feedback based on human-scaled experience. Students and participants used markers to communicate ideas by drawing on the presentation materials.

After each co-creation activity, students filled out a questionnaire and participated in a short semi-structured interview. Students were also engaged in an end-of-semester interview to record their impressions about participatory co-creation methods. Data from questionnaires were analyzed using basic descriptive statistical analysis as well as content analysis for open ended questions. Interview transcripts were analyzed using open and axial coding.

The findings show that the combination of tangible props and the collaborative nature of each of the activities helped the students, the users, and the consultants to understand, ideate, and communicate needs and ideas. A better understanding of ideas and needs led to a more efficient

design process as the students reported benefits such as being able to make more informed design decisions that responded to user needs and expert consultation, enhanced communication and decision making with their peers, and a more fully developed and realistic final project that met the integrated goals of the studio. Figure 4 shows the role that each activity played in helping understand insights throughout the design process.

Important Definitions

This section provides working definitions for key terms used in this document. In addition, it also provides clarification for terms repeatedly used in the methodology section.

Participatory design: Participatory design is defined as a design process that utilizes a participatory mindset that sees users as partners and a combination of a design and research-led approach (L. Sanders, 2008).

Co-creation: Co-creation is defined as any act of collective creativity shared by two or more people where multiple stakeholders collectively engage in design development processes (Sanders & Stappers, 2008). Co-design is one instance of co-creation.

User-centered design: User-centered design (UCD) is a design process that utilizes methods to understand user needs. In this research-led approach researchers and designers are considered domain experts. The goal of UCD is to use primary and secondary methods to better understand user needs.

Empathy: Is defined as “our intuitive ability to identify with other people’s thoughts and feelings, their motivations, emotional and mental models, values, priorities, preferences, and inner conflicts”(Thomas & McDonagh, 2013, p. 3).

Comprehensive: Is defined as “covering completely or broadly” (Merriam-Webster, 2018). It is used to describe an evaluation of a broad range of topics or knowledge.

Integrated: Is defined as “various parts or aspects linked or coordinated” (Oxford-University-Press, 2018). It is used to describe the concept of how a comprehensive range of aspects are related.

Terms Needed to Understand Methodology

The methodology section refers to two types of participants. It is important to note the difference between these two. “Internal participants” will refer to the students enrolled in the architecture studio that have consented to participate in the study. “External participants” will refer to the external people that participated in the co-creation activities. These included museumgoers (end-users), museum employees (end-users), specialty consultants, design consultants, and museum curators.

End users: The term “end-user” or “user” refers to external participants that represent people that would work in a museum as employees, or that would visit a museum as guests.

Design consultant: The term “design consultant” refers to external participants that represent the role of consultants that traditionally work with architects during the design of buildings. They include interior designers, structural engineers, and mechanical engineers.

Specialty consultant: The term “specialty consultant” refers to external participants that represent consultants that are not traditionally directly involved in the process of designing buildings but have expertise that is valuable to a project.

Prop: The term “prop” refers to any tangible medium that acts to elicit a response from a participant about their existing experiences and needs, or that helps them generate and communicate ideas about the future. Used here, props embody probes, which are materials intended to help users evoke existing experiences, feelings, and views (Mattelmäki, 2005). Props

also embody toolkits, which are sets of materials that allow users to participate as co-designers by helping them communicate ideas about the future by making (L. Sanders & Stappers, 2014).

Semantic: The term “semantic” refers to the meaning that people associate with something based on its form and aesthetics (Krippendorff & Butter, 1984). In this study, the term “semantic” specifically refers to the emotional and functional meaning that certain forms and aesthetics of architectural space convey to people.

Limitations

The internal participants (students) of the study had no prior experience with co-creation. Students were only provided one training workshop on how to facilitate participatory co-creation sessions, as well as written instructions and descriptions of each activity. Results could have varied if the internal participants could have received additional training.

Budget and time didn’t allow for external participants to be screened by the primary investigator. External participants agreed to participate voluntarily and were not provided any incentive. Results could have varied if external participants would have been screened or incentivized. External participants were recruited based on proximity and convenience. Some included graduate students for other disciplines, university faculty, or university staff. Conducting a study with professionals and users (with some incentive) would yield different results.

Time limits were placed on the co-creation activities due to conflicting schedules and limited availability of external participants during scheduled studio hours. Results could have varied if more time had been allotted for co-creation with one group of external participants, or for co-creation with more groups of external participants. Findings were based off data collected from participants during or referring to the activities. Development of student projects that

wasn't informed by the activities, such as inspiration from the professor or other sources of information, was not included in analysis. The use of a comparison group was also not included in the analysis. Qualitative data from interviews was the primary source of the findings.

CHAPTER 2. LITERATURE REVIEW

Integrated Architecture Studio Pedagogy Approaches

As the role of integrated studios become more imperative to prepare architects for the growing complexity of the profession, alternative models of teaching integrated design in architecture studios have emerged. Generative drawing is one approach to studio pedagogy to help students comprehensively integrate research and complex conceptual and technical systems of design. At the University of Cincinnati, Wallick (2012) used generative drawing as an approach to integrated design studio. In this process, students documented insights from contemporary architecture precedent research through the act of drawing. Throughout the semester, students continued to explore new ideas by building on this drawing. As all ideas are always in front of the students' eyes, this method helped students to integrate decisions about research, site and context, technical details, and conceptual concepts simultaneously by comprehensively identifying relationships between them and building upon those relationships in the drawing.

As digital design software has become more intelligent, its value as a tool for evaluating and integrating comprehensive design decisions has also resulted in new approaches to architecture studio pedagogy. The emergence of BIM (Building Information Modeling) and sustainability analysis software have provided methods for comparing the complex effect that different variables have on the efficiency of building systems. Kaiser and Ogoli (2016) studied the learning outcomes of the use of sustainability software in an architecture studio. Using sustainability software throughout the design process helped students to evaluate the environmental impact of their designs and continue to make adjustments to the form, materials,

structure, and mechanical systems in an integrated fashion. This method helped students to more comprehensively develop their building concepts in a studio environment.

Digital advancements have also influenced the rise of new studio pedagogies that focus on digital fabrication and materials research. In their study, Riether and Wit (2015) present the impact of digital fabrication in teaching students comprehensive skills in studios. Working together, students in the studio used 3D modeling and analysis software to explore ideas for a pavilion, develop new fabrication processes, analyze and innovate upon materials, and cost. They also constructed the pavilion and figured out logistics of material transportation and site selection. This study sets a precedent for a pedagogy of studio that is self-organizing and helps students to comprehensively address real world issues of site, materials, fabrication, and budget using digital software tools.

The design-build studio is one of the more popular alternative approaches to studio pedagogy because of its value in providing students with practical experience of a holistic design process. A prominent example of design build studio pedagogy in architecture is the Rural Studio, a program at Auburn University. Students in this design-build studio design and build houses and community buildings to improve the lives of people in impoverished communities using limited funding and recycled materials. Students work closely with members of the community to explore creative design options that respond to material, sustainability, and cost constraints by creating drawings, testing physical mock-ups, and constructing the building (Hursley, 2017).

Aside from the practical technical skills that design-build provides students with, this pedagogy also provides comprehensive external stakeholder perspectives with a unique participatory approach to studio education. Interaction with communities during the process has

enhanced students' awareness of place and culture while designing and has provided sources of inspiration to address meaningful problems within communities (Canizaro, 2012). Students also work closely with consultants and contractors to help guide their design, engineering, and construction decisions (Canizaro, 2012).

While the participatory approach used in design-build studio pedagogy has shown value in helping students address goals of comprehensive studios, there is no documentation of when users and consultants should be included in the studio process. There are also no documented participatory methods or descriptions for how these interactions between students and external stakeholders should be facilitated to effectively gain information and insights.

Towards a Participatory Approach in Studio Pedagogy

Including users as equal participants in the design process, the participatory design approach, has gained popularity in design research. The interactive nature and the physical artifacts (probes) used to facilitate co-creation activities help future users to articulate their latent and tacit needs (L. Sanders, 2008). Mattelmäki (2008) reports case studies in which probes helped users reflect, observe, and document their experiences and feelings. Probes facilitate dialogue between users and designers and allow users to explain rationale behind their decisions. Understanding user needs and the supporting rationale is critical for designers to develop innovative design solutions.

Innovative solutions are arrived at in participatory design through generative co-creation methods. Co-creation activities provides an interactive medium for users to explore and communicate tacit and latent ideas about the future (Sanders & Stappers, 2014). Common co-creation tools include Velcro modeling, collages, role playing, and physical mock-ups of products (Boradkar & Dhadphale, 2018; Sanders, 2002).

Clark and Brown (Brown & Clark, 2013) critique the traditional architecture studio of restricting the creativity of students to the restraints of pleasing the instructor. They suggest that a structured platform needs to be provided in studios that can enhance students' ability to creatively play and explore creative options without inhibitions. The use of co-creation tools such as the act of making and role playing could provide such a platform to enhance creativity and collaboration in architecture studios. They could also serve as a platform for students to gain perspectives and information from outside of the studio to inspire comprehensive design.

Participatory Co-Creation Methods in Architecture

While case studies of co-creation methods being used in an architectural context are increasing, the use of these methods lies primarily in the front-end of the design process. The 'Building Schools for the Future Program', requires every secondary school rebuilt by the year 2021 to include students' and teachers' voices in the design development process (Newman & Thomas, 2008). Newman and Thomas (2008) reported on participatory co-creation methods being utilized by such schools to understand students' views on space configuration and possibilities for design. Methods used by one school district involved children of diverse backgrounds researching a specific part of their school, ideating innovative solutions, and modeling reimagined and desired possibilities for those spaces. Physical modeling provided students a method to collaboratively explore and communicate ideas. Collaborations between students of diverse backgrounds provided insights about the needs of collective and underrepresented users. While student contributions yielded unique insights, contributions weren't considered by the architects. This lack of consideration may have been because the architects were not involved in the co-creation. The author suggests that further co-creation methodologies be conducted that aid users in participating past the front-end of design so that

their input is expressed during the decision-making phases. According to Sanders and Stappers (E. B.-N. Sanders & Stappers, 2008), user participation at the moment of decision making is important to ensure that user needs are accurately designed for.

Designer led co-creation. In contrast to the lack of architect participation in the co-creation activity reported by Newman and Thomas, Turhan & Doğan (2017) conducted a study with students in an industrial design studio that led a co-creation activity with users to gain insights. Gaining insights directly from users during co-creation provided the students with an empathy for the users that they used to design concepts more comprehensively aligned with user needs and desires.

Consistent user participation. Similarly, Howard and Somerville (2014) report the outcomes of design to align more closely with user needs and expectations when users are involved throughout all phases of the design process. They compare the effects of participatory design from two design projects for a university library; an architect-led project to renovate the inside of the library, and a landscape architect-led project to redesign an exterior library courtyard. Both projects included a participatory design charrette at the beginning of the project that involved ideation, evaluation, and modeling. Landscape architects facilitated all co-creation activities and interacted with and informed users at all phases of the design process to verify that solutions aligned with their needs. Architects only interacted with users in the ideation phase and interpreted user insights to make decisions. The process led by landscape architects yielded design that better aligned with the needs and expectations of users.

Tangible Props. The use of tangible props and making have also shown to be valuable co-creation tools in helping users to creatively express needs and ideas about the future. Xu and Lozanovska (2013) document a case study of an architectural design studio where students led

groups of primary school children in designing a new school playground using exploratory model-making techniques. The architecture students led children in storytelling and abstract modeling to discover creative opportunities, drawing and modeling to ideate, and prototyping to test. Tangible making helped the children (users) explore and communicate needs through creative generation and rethinking of simple playground equipment.

Similarly, a paper by Dindler (2010) discusses the role of tangible props in generating new solutions for architectural problems. He describes a case study where museum specialists developed and role played a narrative for a new way of experiencing exhibits within museums by using common commercial furniture and products as props. Abstracting the meanings of these props fueled the imagination and collaboration between participants to design a novel experience for exhibit design.

Conclusion

As the approaches to architecture studio are diversifying to help students meet the goals of integrated design, the participatory approach is becoming more popular. There is a lack of a documented methodology to help educators implement participatory approaches into the existing structure of architecture studios past the point of facilitating unstructured conversations between students and external stakeholders. The study by Xu and Lozanovska (2013) serves as an example of structured co-creation methods led by architecture students to include users as co-designers throughout the entire process. Although led by architecture students, the participatory methods used were not centered around building design.

Structured co-creation methods centered around building design, such as the study by Newman and Thomas (2008), display effective methodologies and modeling tools to help users participate in the design process and express creative tacit and latent thoughts. There is

opportunity to develop similar co-creation methodologies for use in comprehensive architecture studios to facilitate effective participation with users and consultants in the design process. For these methods to be effective at helping students create outcomes that align with stakeholder needs and suggestions, participatory studies in professional practice suggest that co-creation activities in studio pedagogy should be structured in such a way to facilitate stakeholder participation throughout the design process.

Additionally, the participatory approaches to studio pedagogy presented have taken place outside of the traditional architecture studio context. There is opportunity to address how participatory approaches could be integrated into the context of a traditional comprehensive architecture studio with structured platforms of co-creation.

CHAPTER 3. METHODOLOGY

Introduction

The study was conducted in a graduate architecture studio over the course of a 17-week semester. The architecture studio met 3 times a week from 1:00 pm to 5:00 pm. To maintain a natural environment and maximize ease of participation, all of the co-creation activities occurred in studio and during these allotted times.

Students were first engaged in a co-creation training workshop. Following this, students were tasked with leading 3 co-creation activities in the semester. Figure 1 displays the timeline and methodology for each of these activities.

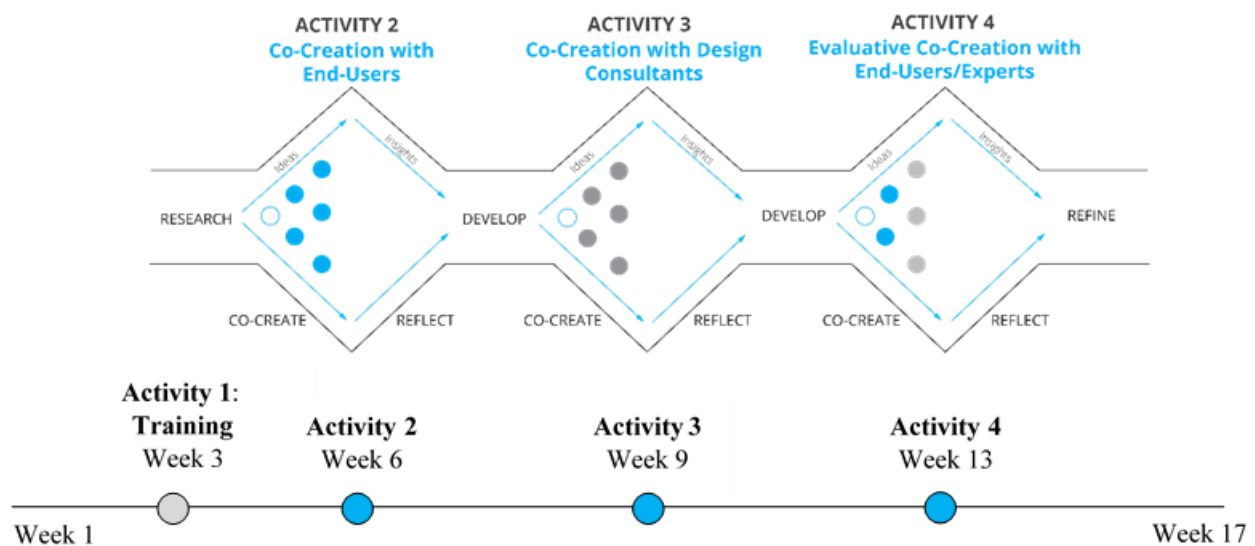


Figure 5. Diagrammatic representation of the timelines and methodology of the study.

Internal Participants

The study required a differentiation between 2 types of participants. The students of the architecture studio that were invited to participate in all 4 activities will be referred to as internal participants. Students were recruited and required to sign the IRB approved consent forms. The study does not include any personal identification information regarding any participants. Pseudo

names were used during analysis. A total of 14 students participated in the study. See Appendix I for IRB approval documentation.

External Participants

The external participants were outside people recruited as participants for the co-creation activities. The external participants were invited to participate in the activities to represent the perspectives of end-users of the building or the perspectives of design or specialty consultants. End-users included museumgoers, students from other disciplines, and faculty and staff with relevant experience related to museums. University staff or faculty from the arts including museum curators and artists were also invited. Consultants include faculty and professionals with relevant experience in building design, structures, HVAC, curation, and others. Twenty-six external participants were recruited for the study.

Activity Design

Activity 1: Internal Co-Creation Training Workshop



The first activity was a training workshop designed for students participating in the study. The goal of the training workshop was to teach students how to facilitate co-creation sessions. Students were first engaged in a short presentation followed by lessons in how to conduct co-creation activities.

Activity procedure. The success of co-creation sessions largely depends on the ability to facilitate and the props used during the session. For this study, participants were introduced two types of formats: 2-D and 3-D floor plans and models. Figures 6 and 7 show the two different

formats used for this workshop. Each participant facilitated two training sessions using 2-D and 3-D floor plans and models.

For each activity, a list of common spaces in museums, two-dimensional cardboard floorplans or 3-D dimensional floor plans with exterior walls, post-it notes, pens, multiple colors



Figure 6. 3-D model interface

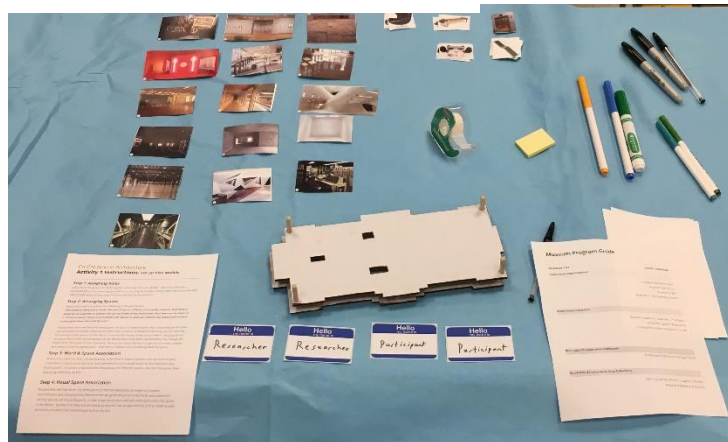


Figure 7. 2-D plan model interface

of markers, Sharpies, multiple pairs of scissors, ¼" wide wood dowels cut into pieces to be used as model columns, loose sheets of white paper, pictures of museums representing different semantic experiences, pictures of stairs and elevators, thumbnail images of furniture with different functions and aesthetics, and a large piece of blue paper to cover the table and act as a drawing surface. Apart from the difference between the 2-D or 3-D floor plan, the same materials were provided for all training exercises.

The 3-D model interface consisted of a floorplan of 2 levels of a popular museum. The footprint of the floorplan was modeled out of 1/8" transparent acrylic. The exterior walls of the level were made of 1/16" chipboard and accurately represented the height of the ceiling, and window locations. Two levels of the floorplan provided could be stacked on top of each other to provide an idea of realistic spatial conditions. Transparent floor plans enabled participants to view spatial relationship between spaces.

The goal of activity 1 was to experiment with different interfaces and props for co-creation. Students experimented with both 2-D and 3-D floor plans. Researcher gathered comparison feedback related to 2-D and 3-D floor plans. This activity helped to determine the best medium for conducting future co-creation activities.

Students in the studio were divided into researchers and participants. Each student was required to facilitate 1 co-creation session and participate in 1 other session. The goal was to experience both the facilitator and the participants' perspective during co-creation. The co-creation activity was designed with three specific goals. First, students (in the participant role) were asked to conduct spatial arrangement for a museum. Participants were provided a list of key space and were allowed to add additional spaces. After spatial arrangement, participants were asked to write 2-3 adjectives that best describe the space. Participants could repeat adjectives for different spaces. After the adjective exercise, participants were asked to place pictures of museum interiors representing different spatial semantics. The images included furniture, lighting, colors, interior spaces and other semantic clues.

Activity 2: Co-creation with Users



Activity 2, co-creation with users, was conducted during week 6 of the semester. Before this phase, students had conducted in-depth research on museums design, spatial needs, and precedent studies. The goal was to gain insights from the co-creation activity that could be translated into design criteria that guide the design development process. 13 students participated in this activity. Students were organized into 5 teams of 2 people and 1 team of 3 people. Each team conducted the activity with external participants for 30 mins. External participants included two categories of people: those that represent the needs of general museum visitors or guests and those that represent the needs of museum employees. Museum employees included a building facilities maintenance manager, a janitor, a food service manager, and a local curator. Museum guests included graduate and undergraduate students from Integrated Studio Arts and Museum Studies classes. Each co-creation session included at least one external participant representing a museum guest and one museum employee.

For each co-creation session, participants were provided with different 2-D shapes that represented assorted sizes of spaces and Play Dough to help with 3-D spatial visualization. Participants were also provided with a list of common spaces in museums, post-it notes, pens, multiple colors of markers, Sharpies, multiple pairs of scissors, ¼” wide wood dowels cut into pieces to be used as model columns, loose sheets of white paper, pictures of museums representing different semantic experiences, pictures of stairs and elevators, thumbnail images of furniture with different functions and aesthetics, and a blue piece of paper covering the table to act as a drawing surface. Figure 8 shows materials utilized for activity 2.



Figure 8. Materials provided for activity 2

Activity procedure. Student teams facilitating the co-creation sessions were provided written instructions on how to lead the co-creation activity. The researchers were present for the activity and answered questions. External participants were first required to arrange space within the provided floor plans using a sharpie and post-it notes. Participants were encouraged to add new space or edit existing floor plans. After the spatial arrangement, external participants were asked to write-down 2 adjectives that best describe the space for each space that they had placed in their model. External participants discussed the choice of words and explained the rationale behind their discussions. After the adjectives had been placed, external participants had to match the spaces and their respective adjectives with provided pictures of museum interiors. The images represented different semantics or atmospheric qualities. Additionally, they were asked to place the images of furniture in spaces that fit in functionally or semantically with what they wanted for that space. External participants were then encouraged to articulate their reasoning behind placing images. External participants were asked to walk through their decisions and rationalize their arrangement of spaces and their semantic attachments.

Activity 3: Co-creation with Consultants



Activity 3, co-creation with consultants, was conducted during week 9 of the semester. Before this activity, students had created schematic plan designs of their projects using criteria formulated based on insights from activity 2. The goal was to gain insights from the consultants to achieve solutions related to the design criteria through technical development. 9 students participated in this activity. By this point in the semester, the students had organized into project teams of either 2 or 3 people. During this activity, there were 3 teams of 2 students and 1 team of 3 students. External participants representing interior design consultants included a graduate student, 2 interior designers employed by the university, an interior design professor, and an art professor, and a librarian representing a curator. External participants representing engineering consultants included a university employed engineer, a structural engineering professor, a mechanical engineering professor, and an architecture professor with a specialty in materials and building science methods. Both types of consultants were split up evenly into two groups. Each team of internal participants conducted the activity once with a group of interior design consultants for 20 minutes and once with a group of engineering consultants for 20 minutes.

For each co-creation session, participants were provided with paper floorplans pasted on chipboard cutouts of each level of the project at hand's schematic design, post-it notes, markers, pens, Sharpies, Playdough, 1/4" wide dowels cut into pieces to be used as model columns, pictures of museums representing different semantic experiences, pictures of stairs and elevators, tape, scissors, thumbnail images of furniture with various functions and aesthetics, and a blue piece of paper covering the table to act as a drawing surface. Color and material swatches were also

provided to be used by the interior design consultants but were available for use in the engineering sessions. Figure 9 shows the materials utilized for both the interior design and engineering consultant sessions. Additionally, some students provided supplementary presentation materials such as 2-D sections and physical site models.

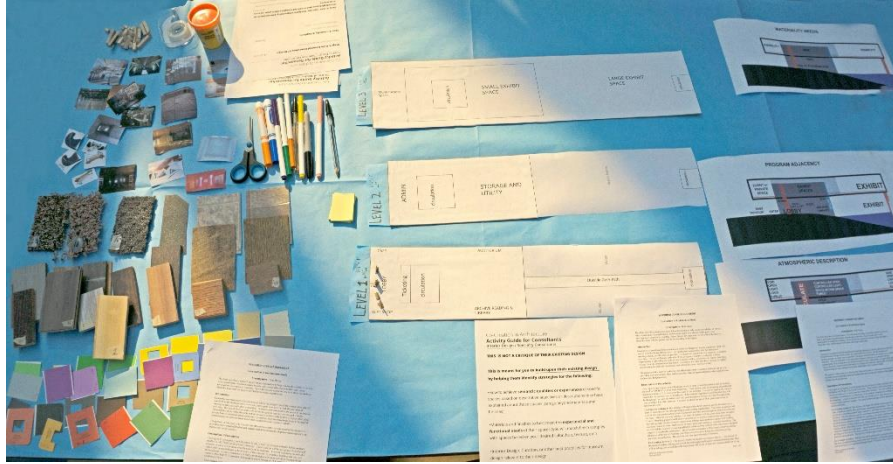


Figure 9. Materials provided for activity 3

Activity procedure. Student teams facilitating the co-creation sessions were provided written instructions on how to lead the interior design consultant and the engineering consultant sessions. Both sessions began with the students describing their schematic design concept and design criteria of spaces using the chipboard floorplans. Within the engineering consultant sessions, the students then expanded upon technical criteria for their building such as environmental comfort conditions. The consultants then had to provide feedback on mechanical services integration, structural grid, areas of structural concern, and any other building science related concerns relevant to the students' conceptual and technical design criteria. Consultants were asked to walk through their decisions and rationalize them based on their expertise. Within the interior design consultant sessions, the students provided adjectives and imagined activities for each space within the floor plans. The consultants then had to match provided semantic pictures and material and color swatches with the spaces to best explain how to achieve the

adjectives and imagined activities with interior design principles. The images represented different semantics or atmospheric qualities. Consultants were also asked to explain the interior design principles behind their decisions including curation, furnishings, finishes, and circulation. Students were asked to further probe the consultants with any specific questions related to design of the interior spaces.

Activity 4: Evaluative Co-Creation with End-User/Experts



Activity 4, co-creation & verification with experts/users, was conducted during week 13 of the semester. The goal of this activity was to support the refinement phase. The activity provided users and curators with props that would help them understand and visualize the experience of the building. The goal was to gain insights from users and consultants on what was working well in their museums, and what elements could be improved or refined. 12 students participated in this activity. The internal participants remained separated in their project teams of 2-3 people. External participants representing guest end-users included a university faculty member that had visited many museums, and an art professor. External participants representing employee end-users included a librarian and a facilities maintenance manager. End-users were split up into 2 groups of 2 and 1 group of 1. External participants representing curators included a retired museum curation consultant, an art professor, a museum exhibit designer, a photography professor, and a visual literacy educator for a museum. They were split up into 2 groups of 2. Each team of students conducted the activity at least once with a group of end-users for 20 minutes and at least once with a group of curators for 20 minutes.

For each co-creation session, participants were provided with presentation posters that included floor plans of each level, building sections, 3D exploded axonometric drawings of the building, and high-quality renderings of both the exterior of the building as well as the interior. Post-it notes, pens, multiple colors of markers and sharpies were also provided. Figure 10 shows the materials utilized for the sessions. Additionally, some students provided supplementary materials such as physical site models.



Figure 10. Materials provided for activity 4

Activity procedure. Student teams facilitating the co-creation sessions were provided written instructions on how to lead the end-user sessions and the curator sessions. Within the curator sessions, the students first identified a specific gallery or exhibit in their museum that was important to their design concept. They then explained the content that would be displayed in that space, the significance of the exhibit or gallery, and 3 adjectives that described the desired experience they were intending to create. The curators then walked through how lighting, materials, and finishes could be used to achieve these goals and to walk through the logistics of curating the exhibit from design to assembly and maintenance. Following this, the curators identified what type of exhibit media would be best suited for display in other exhibit spaces

within the museum. Curators were asked to focus their responses on spatial arrangement, semantic quality, lighting quality, set-up, and maintenance.

Within the end-user sessions, the students waked the users through the most dynamic and memorable experience they anticipated for the visitors of the museum. They then described the experience with 2-3 adjectives and explained how they had used lighting to create this experience. Responding to this, end-users commented on how they felt the lighting achieved the atmospheric goals described by saying what they liked, what they didn't like, and what they would change. This process of explanation and feedback was repeated around the topic of materials and finishes, as well as with furniture.

Methods of Data Collection

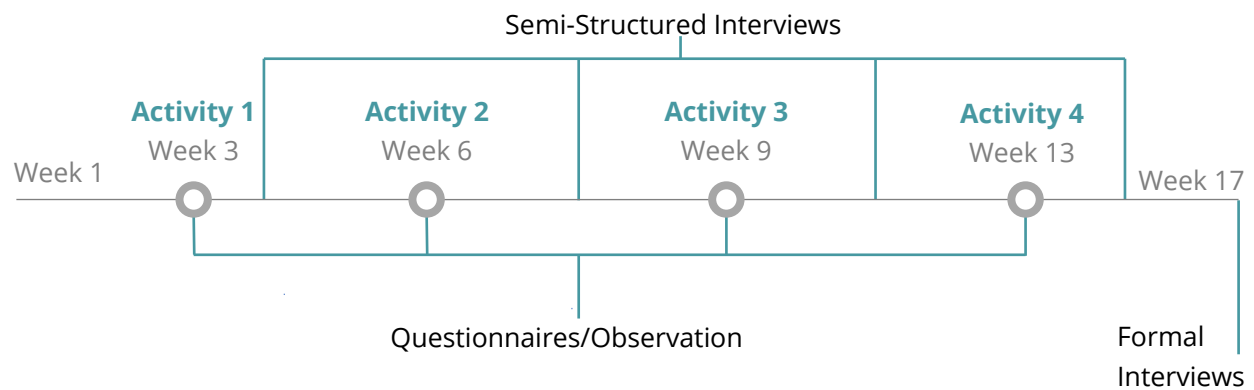


Figure 11. Timeline of data collection points.

During the co-creation activities, participant observation was conducted by research to understand the flow of activities and to record any issues related to props or participation. As an observer, the researchers ensured that participants stayed on topic and completed task in the given time. Researcher attempted to be the least involved and intrusive, so as not to influence the data. Researcher recorded observations using notes and photographs. After each co-creation session, the researcher would do reflective journaling to write down all thoughts and initial

insights about the activity. Photographs taken during the activities were then used to add additional thoughts to the researchers' reflective journaling.

Questionnaires

Students (internal participants) completed a questionnaire after the training workshop. The goal of the survey was to understand effectiveness of the workshop, to gauge acceptance of the participatory co-creation as a new methodology and if participants felt confident of facilitating the co-creation sessions in the future. The questionnaire (see Appendix A) included Likert scale questions and some open-ended questions to document students' reflection on training workshops.

Students were also engaged in questionnaires after activities 2, 3 and 4. The goal of this survey was to gauge effectiveness of co-creation in understanding user needs, gaining insights and developing design criteria. The questionnaires (see Appendix B, C, and D) specifically focused on understanding students' view on gaining insights related to user circulation paths, semantics, functional needs of users, structural needs, mechanical systems needs and integration, materials and finishes, exhibit design, and lighting. Each survey also required participants to share three key insights gained from each co-creation session.

Semi-Structured Informal Interviews

After each activity, the researcher engaged students (internal participants) in a semi-structure informal interview. The goal of this short interview was to capture students' impression about each activity. The researcher took detailed notes during the interview. Interviews were not audio recorded.

End-of-Semester Semi-Structured Formal Interviews

More formal semi-structured interviews were conducted after all co-creation activities were completed. Interviews were conducted during week 17 of the semester. A total of 9 of the 14 internal participants participated in the interviews. All interviews were audio recorded and transcribed by the researcher. Each student (internal participant) was shown a PowerPoint presentation that visually summarized each co-creation activity. This was done to refresh participants' memory regarding all co-creation activities. The goal of the interview was to record participants' opinion on the effectiveness of the co-creation activities, choice of materials (props), sequence and duration of activities, and the insights gained from each activity.

Methods of Data Analysis

Topic Coding

Early analysis of qualitative data was conducted using topic coding. Topic coding is a technique used to separate text passages from the data into categories based on content so that it could be more easily analyzed (Richards, 2015, p. 110). Each activity was coded and analyzed separately so that the effects of the study on the students' projects could be traced back to the activity that affected it. The following table summarizes key topics identified from each co-creation activity.

Table 1. Coded topics from each activity

	Activity #1	Activity #2	Activity #3	Activity #4
Key topics	<ul style="list-style-type: none"> • Benefits of working in a 3D or 2D Interface • Semantic/ Atmosphere • Circulation/ Program Arrangement • Catalyst for Creativity/ Ideation/ Communication • Group/ Collaboration Effects • Timing in Design Process • User-Centricity/ Realism • Administrative/ Conducting Activity Experience • Lessons Learned for Conducting Activity 	<ul style="list-style-type: none"> • Conducting with Users Compared to Activity 1 with Students • Catalyst for Creating/ Communicating • User Insights • Semantic Atmosphere • Functional Needs of Users/Furniture • Timing in Design Process • Prop Effectiveness • User-Centricity/ Realism • Administrative/ Conducting Activity Experience • Flow of Activity • Lessons Learned for Conducting/ Replicating Activity • User Type Differences • Group/ Collaboration Effects 	<ul style="list-style-type: none"> • Consultant Insights • Catalyst for Creating/ Communication • Circulation insights • Timing in Design Process • Activity 3 compared to Review • Prop Effectiveness • Administrative/ Conducting Activity Experience • Lessons Learned for Conducting/ Replicating Activity 	<ul style="list-style-type: none"> • Catalyst for Creating/ Ideation/ Communication • Consultant Insights • Timing in Design Process • Activity 4 compared to Review • Prop Effectiveness • Administrative/ Conducting Activity Experience • Lessons Learned for Conducting/ Replicating Activity

Analytical Coding

After the qualitative data was separated into categories that could be more easily understood and helped to locate specific passages, analytical coding was used to create new categories of data that helped answer the research questions. Analytical coding is the consideration of the meanings of the passages in context, rather than their face value, to create categories that portray new ideas, and theory emergence and affirmation (Richards, 2015, p. 112). This was helpful to separate the qualitative data into themes of benefits that helped to answer the research questions and develop affirmed theories.

Quantitative Analysis

To support theories developed from analysis of the qualitative data, quantitative data

analysis methods were utilized. These methods included analyzing data from the questionnaires by identifying common trends from the Likert scales, comparing means and medians, and correlation statistics.

CHAPTER 4. FINDINGS

Overview

In traditional pedagogies for comprehensive integrated architecture studios, students use tools such as drawing and modeling to explore and test ideas. Modeling qualities range from formal massing models commonly used during the early phases of design to detailed scale models of full buildings commonly built for presentation quality representation towards the end of the process. Student decisions are also guided by feedback from their instructors, reviewers, and project specific experts from outside the studio.

The goal of this study was to understand if and how participatory co-creation methodologies assisted student learning in a comprehensive integrated architecture studio context. Integrated studios include analyzing and evaluating decisions based on comprehensive sources of research, integrating complex technical building systems to support design goals, and integrating design decisions across multiple scales to work as a system. This study addresses 3 key research questions:

1. What is the role of co-creation in gaining insights for an architecture design project?
2. What role did the medium of co-creation play in gaining insights?
3. How did the designers utilize and implement insights gained from co-creation?

Findings will address the role that the props and interactive platform of each activity played in providing students with insights beneficial to their project development at four key points throughout the semester.

Activity 1: Internal Co-Creation Training



Although meant to be a training session for students (internal participants), results show that this activity complemented the precedent research conducted by students and aided in creative project ideation. Students co-created once with a 2-D floor plan and once with a 3-D floor plan. Students noted that the 3-D floor plans were helpful to visualize the spatial parameters and form of museum designs. The use of transparent acrylic floors allowed students to “understand vertical floor to floor relationships” of architectural elements because they could “see through the floors and see space sectionally overlapping”. This sectional understanding of architectural strategies was helpful for students to more fully understand architectural strategies from precedents and case studies being researched in studio by applying them in the model and visualizing them as part of a holistic building instead of in isolated plan or section view.

While the 3-D floorplans helped enhance understanding of spatial parameters and precedent strategies, the 2-D floor plans aided students in creative exploration and experimentation of spatial designs. The ability to easily modify the cardboard plans helped students to easily explore ideas for spatial arrangement and form exploration. Being able to quickly alter models and test ideas without any constraints encouraged creative thinking and helped students get into a state of mind where they weren’t scared to fail and experiment. One student stated that you were “free to show your imagination without any limitation of practicality”, while others noted that it helped them to get active and not be so stringent with their ideation.

The interactive platform of these activities also facilitated collaboration between students, which was helpful to explore and assess viable options for spatial arrangement and semantic development to help students start designing their own projects. The multi-dimensionality of the modeled floor plans made it easier for students to communicate ideas to each other. One student commented that “the props were a way to start off a visual connection for an idea that made it easier to explain what you were trying to say”. The visual documentation of ideas was helpful for students to build off each other’s ideas. One participant said that the activity “helped us organize in way that we didn’t think of because we were collaborating with other people. This was nice because everyone sparked each other’s ideas at the same time. Another said that “brainstorming becomes elementary and easy” in this activity.

This activity helped students feel prepared to lead future co-creation activities by experiencing the value of the interactive platform in generating ideas for their own projects. Some formed a preference for the 2D and 3D props and recommended changes to the interactive platform that could make it more effective for them to gain insights when leading activities in the future. They noted that the 3-D models were too prescriptive with predetermined opening sizes (doors and windows) and that it was difficult to physically manipulate the form and scale of spaces. In contrast to the 3-D, students felt that the 2-D floor plans were limited in terms of visualization of interior space and scale. Some students recommended a hybrid combination of the exploration benefits of the 2-D floorplan with the spatial visualization benefits of the 3-D floorplans. One participant stated that “the 2-D was better to start off in plan because we talked about circulation and things and then tried to convert these ideas into sectional view when we moved to the 3-D model”.

Activity 2: Co-Creation with Users



Still in the research and ideation phase, leading co-creation with end-users (museum guests and employees) helped students (internal participants) discover user needs watching them think and prioritize decisions about program adjacencies, circulation, ambience, and functionality of everyday operations. These insights provided students with a new form of inspiration to develop informed design criteria. The interactive platform of this activity enabled end-users to participate in the design process as co-designers by helping them to creatively express their needs with provided props.

Enabling User Participation and Creativity with an Interactive Platform

The section addresses the research question, “What role did the medium of co-creation play in gaining insights?”, specific to activity #2. The props provided for this activity were helpful for users to visualize space in multiple dimensions and creatively explore, experiment, and convey ideas about spatial arrangements and layouts in museums. Although similar methods of modeling and drawing are used in traditional studios during this ideation phase, the modeling utilized by this methodology was unique because of its use and ability to facilitate inclusion of end-users into the ideation process.

Enhanced spatial visualization. Ideation modeling in traditional architecture studios typically consists of massing and form models that are created and assessed individually by students. The modeling interface utilized in this activity differs from typical massing modeling because it provided a means to visualize interior space from an experiential point of view, as opposed to the visualization of the exterior form of a building.

Pre-cut cardboard shapes and playdough. Students expressed that the pre-cut cardboard shapes and playdough provided as a hybrid interface were “useful because it gave an idea of scale”. Instead of arranging the spaces only in plan, user molded Playdough into columns to add multiple levels to their spatial arrangements, which provided a sense of scale in terms of floor to ceiling height. It was also observed that users made sculptures out of the Playdough to create sculpture gardens and exhibits pieces to provide further visualization and context of scale.

Adjectives and images. The act of placing semantic adjectives and images was helpful for users to visualize the ambience of spaces, instead of just visualizing spaces in a cardboard material. According to one student, the adjectives were better for describing how users wanted it to feel in space and that was most insightful”. Another stated that “the pictures were most helpful because it allowed the users to see what the space was since they couldn't imagine it as well as architects might be able to.”

Traditional modeling and drawing techniques used by architecture students in studio for are typically two-dimensional plan or section drawings, or abstracted building massing models. While these are useful tools for designers to explore spatial options, they may be harder for non-designers to comprehend due to a lack of training in spatial thinking. The props provided in this activity helped the users to visually understand interior spaces and experiences through the medium of multi-dimensional models and supporting semantic images. This visual understanding created a common language for students and users to communicate about architectural possibilities.

Enhanced user exploration & creativity. Different from traditional studio critiques between end-users and students in architecture studios, this methodology was unique because it provided an interactive platform that encouraged users to participate in the design process

instead of simply reporting explicit needs such as types of spaces and sizes. Easily modifiable props enabled users to express their needs through creative thinking and experimentation. Creative exploration was further increased by collaborative decision making facilitated by including diverse perspectives of guest and employee users in the activities.

Easily Modifiable Props. The malleable nature of the props allowed users to easily manipulate shapes and layouts, which helped them to freely explore schematic arrangements of spaces. The pre-cut sizes and shapes of cardboard provided users with a starting place to compare scale, shape, and size of spaces to inform arrangement. It was observed that users easily cut the pieces to create custom shapes and to make floor openings for circulation, and that the easily modifiable nature of the cardboard was most beneficial in facilitating user exploration. For example, one student said that “this hybrid allowed a lot more freedom with manipulating the shapes, heights, etc. Our hand was a lot more free.” It was also observed that the impermanence of the cardboard shapes aided users in experimenting with different spatial layouts. One student stated that “the combination of actually being able to grab the cardboard and being able to draw on it made it easy to manipulate and move it around physically.”

Exploration through drawing. The provided paper underlay was a valuable prop that to inform design decisions of the users. They drew contextual site elements on the underlay such as roads, parking lots, and outdoor amenity spaces. These provided constraints that helped guide design decisions that the users made in the building regarding circulation. For example, one group of users mapped out the connecting paths between main roads and loading docks for service and delivery truck accessibility.

Students also reported that drawing was an effective tool to help users communicate their ideas and to facilitate a conversation with the students leading the activity. One group of students

reported that once they gave the users a pen and told them to draw what they were thinking, “it progressed a lot faster than when they were just talking.”

Diversity of user perspectives. The collaboration that this activity facilitated between multiple types of end-users resulted in the modeling of museum layouts. As users with different perspectives focused their creation towards their specific needs, resulting museum layouts holistically addressed a comprehensive diversity of user needs. Students noted that the museum guests (external participants) focused more on providing architectural and aesthetic feedback while participants representing employee perspectives provided more practical feedback about circulation and storage. Collaboration between these different perspectives helped users to create integrated solutions that comprehensively addressed user needs. One student stated that “It was valuable to see how they (users) all worked together and debated and compromised.”

Models and drawings presented to external stakeholders in a traditional architecture studio are typically viewed as finished presentation materials that are meant to be the centerpiece of conversation. The interactive platform of this activity explored design possibilities (what could be) instead of critiquing the current design (what is).

Co-Creation as a Catalyst to Discover User Needs

The section addresses the research question, “What is the role of co-creation in gaining insights for an architecture design project?”. The interactive platform enabled end-users to creatively express ideas about museum design. This provided the students with insight into how users think and what they prioritize in museums, which helped students to discover user needs that represented a comprehensive sample of museum users. They reported that co-creation helped them to discover and understand user needs related to program and circulation, semantic and ambience, and functional needs.

Program and circulation needs. This co-creation activity was helpful to identify spatial and circulation needs of end-users. One participant stated “It was good to hear what types of spaces real people preferred or didn't prefer. This feedback helped the project to be more realistic.” According to students (internal participants), the feedback gained from museum employees (external participants) was practical and helped them design efficient layouts. Museum employees emphasized the need for quantity and ease of access to storage in museums. For example, a student that talked to a janitor and a food service manager learned that more storage is needed for janitorial purposes and food storage. Similarly, one student listed, on a post activity questionnaire, that their largest insight from the activity was that “you need large amounts of storage in a museum.” Another student stated that some of the insights they took from the janitor and facilities maintenance manager was about vertical circulation needs and the need to stack bathrooms and mechanical services.

Museum guests (external participants) also provided feedback on circulation between spaces. One students stated that “users wanted a clear circulation and wanted to be led where to go in a museum.” Multiple students reported that the guest users expressed interest with where the entrance was located. They also noted that the guest users wanted circulation to the galleries to be clear. Students expressed that doing the activity with multiple types of end-users was helpful in gaining insights. For example, one group of students said that comparing the needs of employees and guests of museums helped them to formulate insights about the need for a clear transition between public and private program. Figure 12 displays the value that co-creation had for students in gaining insights about circulation and program needs.

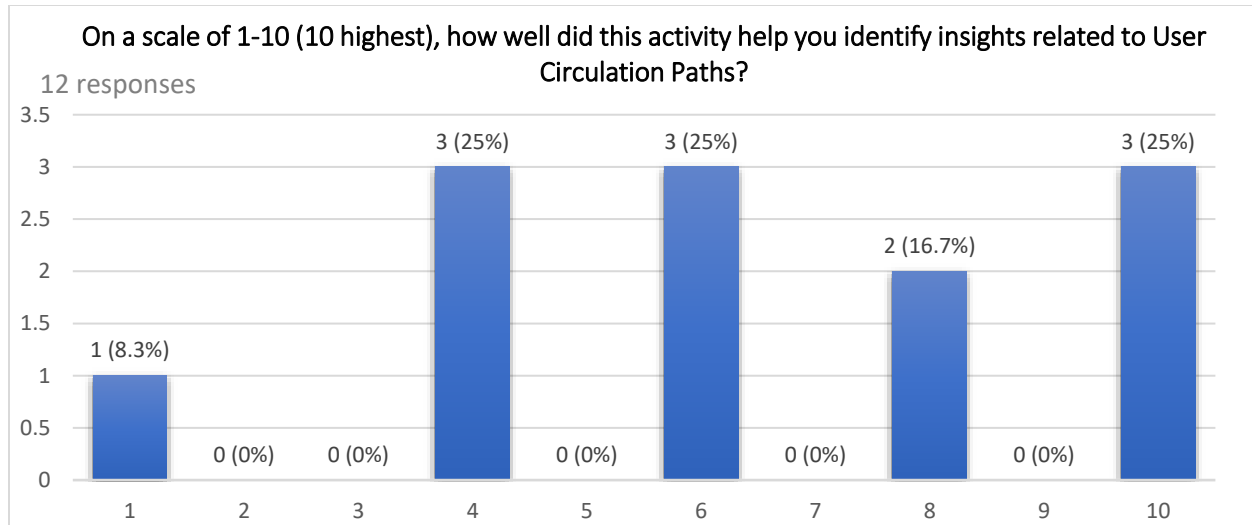


Figure 12. Value of activity 2 in gaining insights about user circulation paths and program needs.

Semantic and ambience needs. The co-creation activity helped students (internal participants) understand experiential and visceral needs associated with museum design. According to one student, it was “helpful to hear their (end-users’) perspective for semantic including characteristics such as light, and what features create the feel of spaces.” Another internal participant commented that the activity helped them think about the needs of different types of users and stated that “this activity was an eye opener for us to think about the employees.” Figure 13 displays how well the activity helped the students identify insights related to semantic.

Functional needs insights. Co-creation helped uncover specific functional needs of end-users. For example, user wanted more seating and places to rest in museums. One reported, on a post activity questionnaire, that an insight was “there needs to be a lot of seating and rest spots”. Another stated that “the users kept putting chairs everywhere because they were older people and wanted to rest everywhere”. Figure 14 displays how well the activity helped the students identify insights related to functional needs of users.

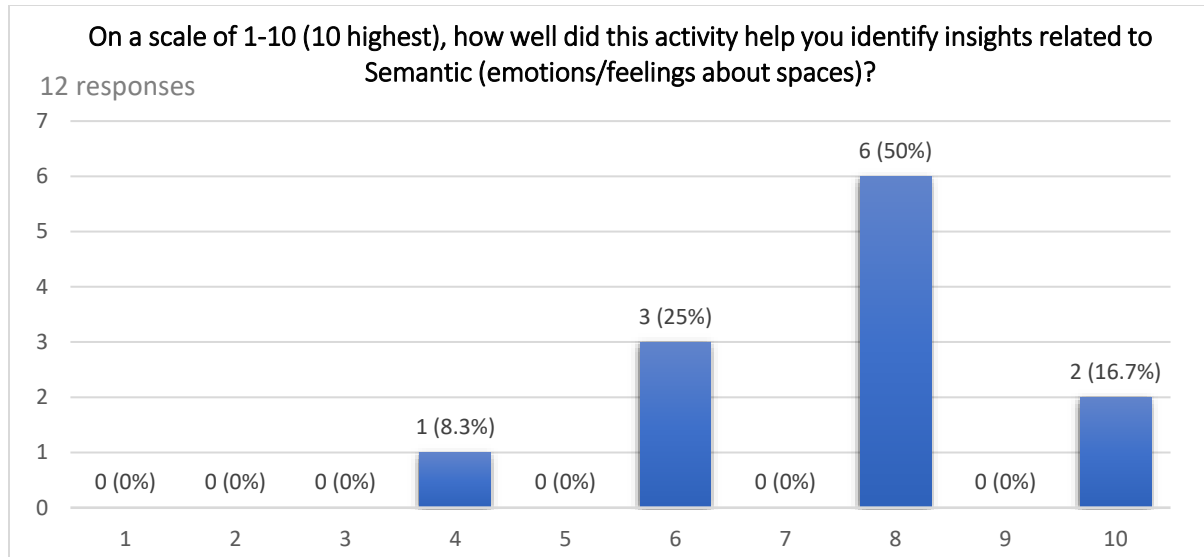


Figure 13. Value of activity 2 in gaining insights about semantics of museum spaces

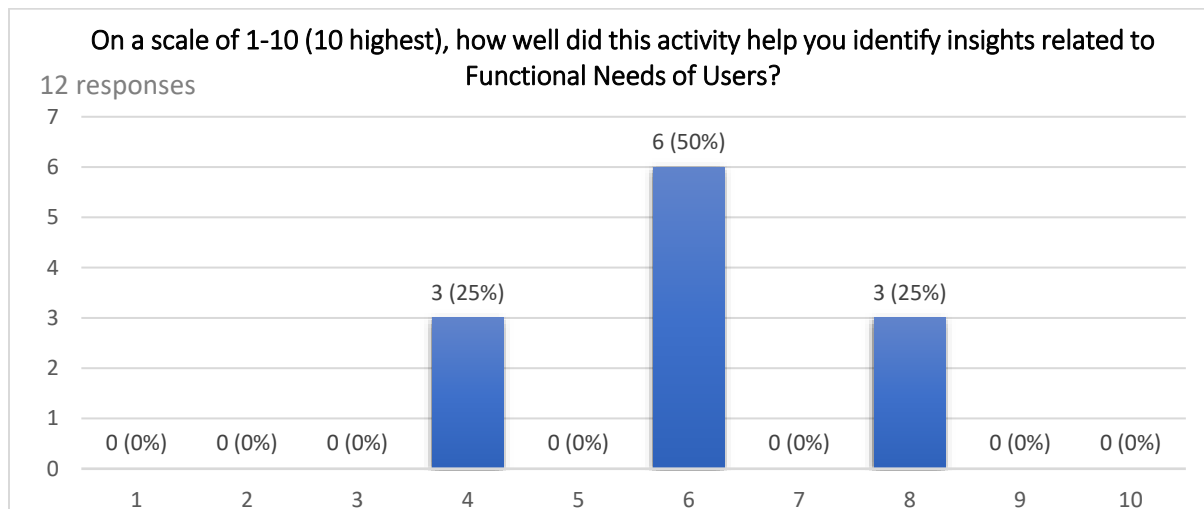


Figure 14. Value of activity 2 in gaining insights about museum users' functional needs

Co-Creation Informed Design Criteria

Students felt that co-creation with end-users positively impacted their ability to generate design criteria for a broad range of actual building users and “offered a new perspective for design inspiration.” The diverse types of end-users involved in the co-creation activity were beneficial for students to gain perspective and created a checks and balances that helped the

internal participants formulate design criteria with an informed consensus. One student stated that “it was helpful to talk to multiple types of users to get a consensus to reach an optimal solution.” Another said that “it was an eye opener to think about the different users in your building and not just lumping them all together into one persona.”

Empathy for users. The activity also instilled a sense of empathy for users that helped students to translate insights about user needs into design criteria. After doing this activity, the students seemed to pen their minds to allowing a user-perspective to help drive their design criteria rather than making uninformed decisions based on what they thought was best. For instance, one student stated, “It was more helpful to do it with the users because their perception of museums was different from mine. Because we are trained more than them, it was helpful to hear a different perspective. It may not be true that we have more training or expertise in buildings because the users are the ones that actually interact with and know what they want from a building. Maybe that is better than what I want.” Another participant said “these activities help you think about all of these dimensions and people's needs that we probably didn't think about and it is super important for us to know about that and talk to those people, so we know what parts are missing or what we need to think about and what parts are not functional. **It's not all about us, it's about the users.**” Figure 15 displays how well the activity helped the internal participants understand user needs. Figure 16 displays the benefits this activity can have in developing design criteria.

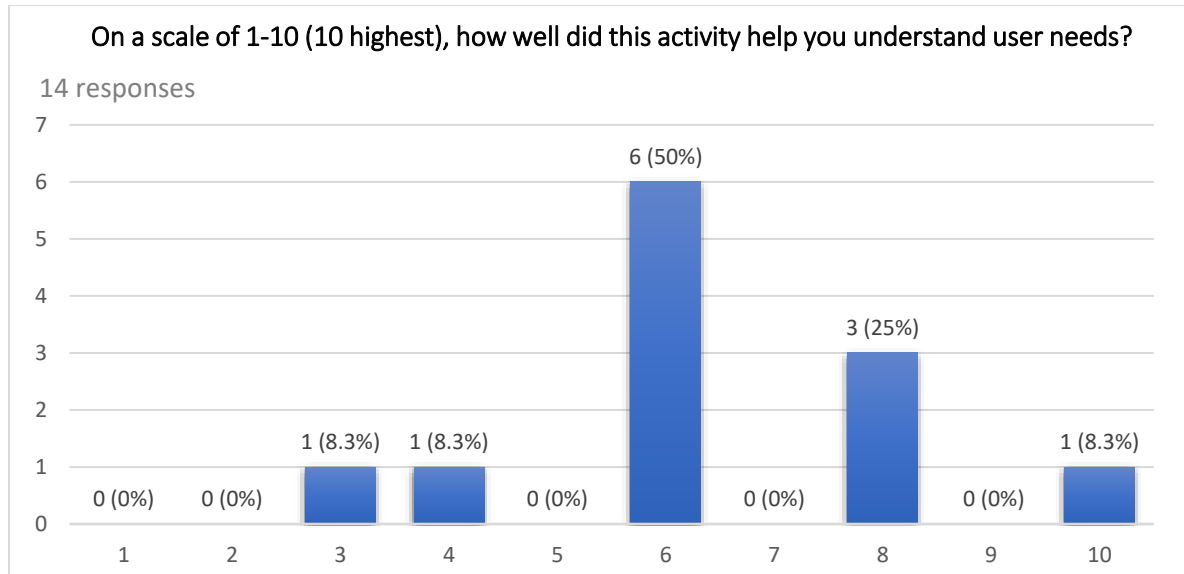


Figure 15. Value of activity 2 in gaining insights about user needs.

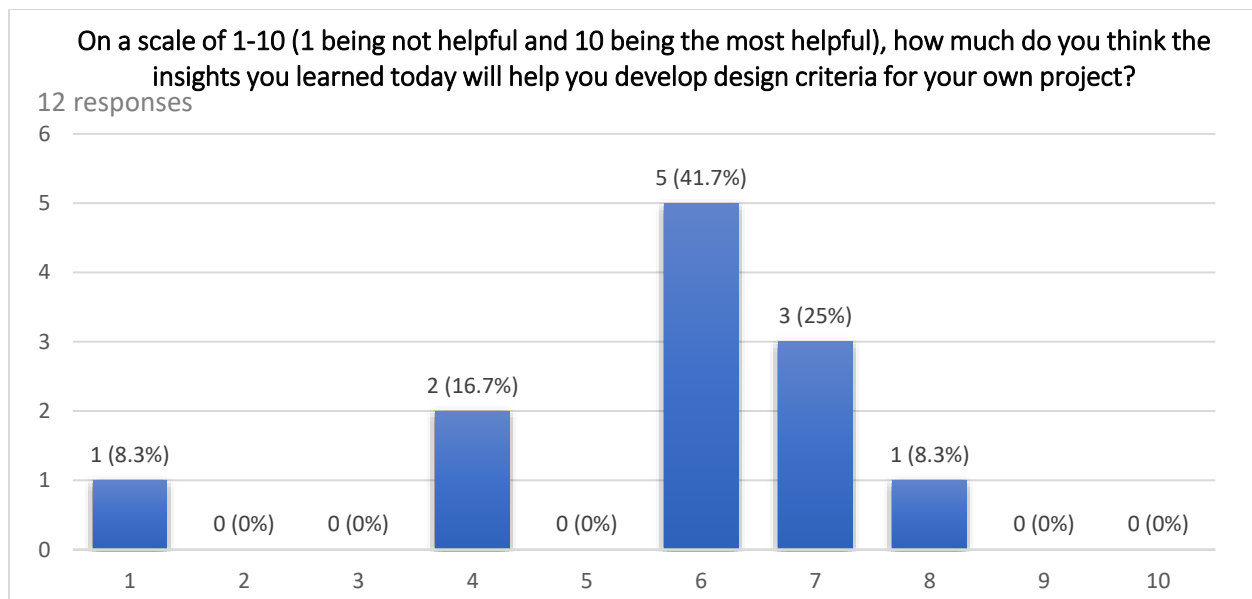


Figure 16. Perceived value of insights gained in activity 2 in developing design criteria.

Summary of Activity 2 Findings

Table 2. Summary of Findings for Activity 2

Benefit of Interactive Platform	Role of Interactive Platform in Gaining Insights	Building Aspects Understood	Role of Co-Creation Insights in Assisting Learning
Enabled Users to Express Creativity	Helped Discover User Needs	<ul style="list-style-type: none"> • Program/Circulation • Semantic/Ambience • Functional Needs 	Helped Develop Design Criteria

This activity provided an interactive platform that allowed users to participate in the ideation phase of the design process. Watching users collaborate with each other to explore and experiment with ideal spatial layouts for museums while voicing their reasoning was helpful for students to understand needs of diverse stakeholders. To answer the research question “How did the designers utilize and implement insights gained from co-creation?” in activity 2, students utilized insights to about user needs to help inform the development of design criteria related to program and circulation, semantic and ambience, and functional needs of users. Examples of design criteria that resulted from these insights included aspiring to create an orchestrated guest circulation path that was intuitive, providing an appropriate ambience for public and private spaces in museums, providing natural transitions between public and private spaces with furniture, including frequent locations of storage spaces to increase employee efficiency, and providing frequent seating options for guest comfort.

Activity 3: Co-Creation with Consultants



This activity was conducted at a point in the semester when students (internal participants) had developed conceptual schematic floor plans of their projects. Using schematic floor plan models as a starting point, co-creation with professional consultants provided students with the technical support to holistically address design criteria and achieve the conceptual vision they were trying to design for. Professional consultants included interior designers, exhibit designers, mechanical engineers, and structural engineers. Interacting with diverse professional perspectives in a collaborative platform assisted students in integrating a comprehensive range of technical and conceptual building decisions simultaneously across multiple scales to bring their studio projects closer to real-life constraints.

Design Development Benefits of an Interactive Platform

Students in architecture studios typically begin design development by creating a schematic floor plan design of their building based on design criteria and conceptual goals. Students alter and develop these designs over the course of the studio, traditionally in response to feedback from architectural professional and instructors on presentation quality drawings and models presented in a critique style format. In more comprehensive architecture studios, professionals and experts from outside the realm of architecture are sometimes invited to review student work in this critique format to expose students to diverse perspectives. The props and methods of this activity differed from traditional involvement of external professionals in architecture studios by providing an interactive platform for students and professionals to collaborate about student work instead of critiquing it. The following sections address the

research question, “What role did the medium of co-creation play in gaining insights?”, in activity number 3.

Collaborative problem-solving platform. Students noted that they enjoyed the collaborative nature of the co-creation activity and that the interactive problem-solving approach was a helpful format for gaining feedback from professionals. The informality of the activity was particularly helpful for students because they could have more of a relaxed conversation with the professionals about their projects and helped them feel more comfortable asking questions that could help improve their projects. “It was nice because it was just a conversation instead of a staged feeling of a review” (Participant 6).

This relaxed format helped engage students and professionals in collaborative exploration that was expressed by students to be productive towards the design development of their projects than a review would have been at this stage. One student stated that “This activity was very helpful because we were getting consultation from them to solve problems instead of it being a critique.” Others commented that, “we gained a lot of information that helped us move forward or add on to our building where reviewers would normally just agree or disagree with our design”, and “the activity was more of a problem-solving meeting instead of a defense.”

Enhanced visualization of student design aspirations. The facilitation of productive collaboration between the students and consultants was enhanced by representative qualities of the props that helped visualize the form of student designs and understand the conceptual criteria and experience they were trying to achieve. This understanding helped consultants provide informed feedback and exploration. Chipboard floorplans were helpful for the consultants to understand scale and spatial relationships (Figure 18). It was observed that having floorplans printed out as separate levels was helpful for students to visually explain their museum schemes

as they would hold them above each other to communicate scale of floor to floor heights. One student said that “it was useful to have all the levels printed out separately, so you could point to it in 3D.”

Adjectives and images were also helpful to communicate the semantic feel of each space. Interior designers were able to understand the ambience much better when the internal participants placed the adjective and the semantic images at the same time.



Figure 17. Activity 3: co-creation with consultants

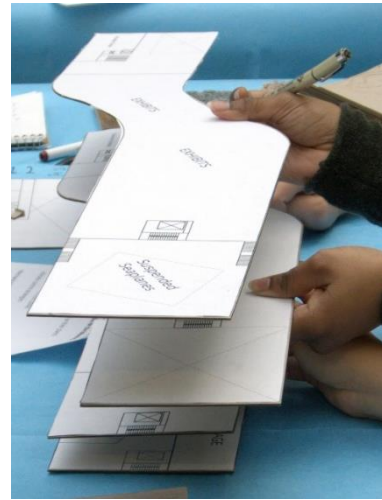


Figure 18. 3-d visualization with chipboard floorplans in activity 3

Informed exploration and communication. The tangible props provided a visual context that helped consultants to make informed exploration and communicate ideas to students. Details such as size and location of elements documented in the schematic floor plans and 2-D building sections helped guide decisions because it provided them with a sense of scale of which to draw solutions at. Drawing utensils, paper, and Playdough helped consultants (external participants) communicate ideas with scale and context. For example, one student stated that “having grid paper was helpful for the mechanical and structural engineer talk.” Additionally, engineering consultants modeled elements such as exhibit pieces with Playdough to provide a context of scale.

Collaborative interactions between students and consultants were enhanced because all the participants shared a common design and construction language. One student stated, “This activity only worked because everyone knew how to read a plan.” Material and color swatches were helpful to facilitate conversations with consultants about aesthetic and functional qualities of specific spaces (Figure 17). One student (internal participant) stated that “interior designers used material swatches as references and placed them.” Another said that “the interior designers played with material swatches to explain what materials are acoustically better.”

Generating Integrated Design Solutions

This section addresses the research question, “What is the role of co-creation in gaining insights for an architecture design project?” As this activity took place at a point in the semester where students were exploring form, massing and schematic arrangements, they expressed it was helpful to start considering how technical aspects such as mechanical systems and structural systems would be integrated with decisions such as program arrangement, circulation, and semantic to holistically address design criteria. One student said that the activity “happened at a good time because we were just starting to think of it as an actual form, so it was good for us to think of how it would actually work as a system instead of looking at it as a physical form.” Another said that “this was helpful at this stage in the process to get a real world take on the project.” Engaging with professionals from diverse perspectives of expertise helped them gain insights to integrate decisions about program and circulation, semantic and ambience, materials and finishes, and building systems.

Program and circulation insights. Co-creation with interior designers and curators helped students’ gain insights into spatial arrangement and circulation. For example, one participant stated that a curation consultant helped them determine how much space they should

allocate to storage and public space. Engineers were also helpful in providing suggesting effective changes about programming. One participant stated that one of the mechanical engineers provided ideas on where to put the mechanical systems within their schematic design at the time. Figure 19 shows how well the activity helped the students identify insights related to circulation paths and programming.

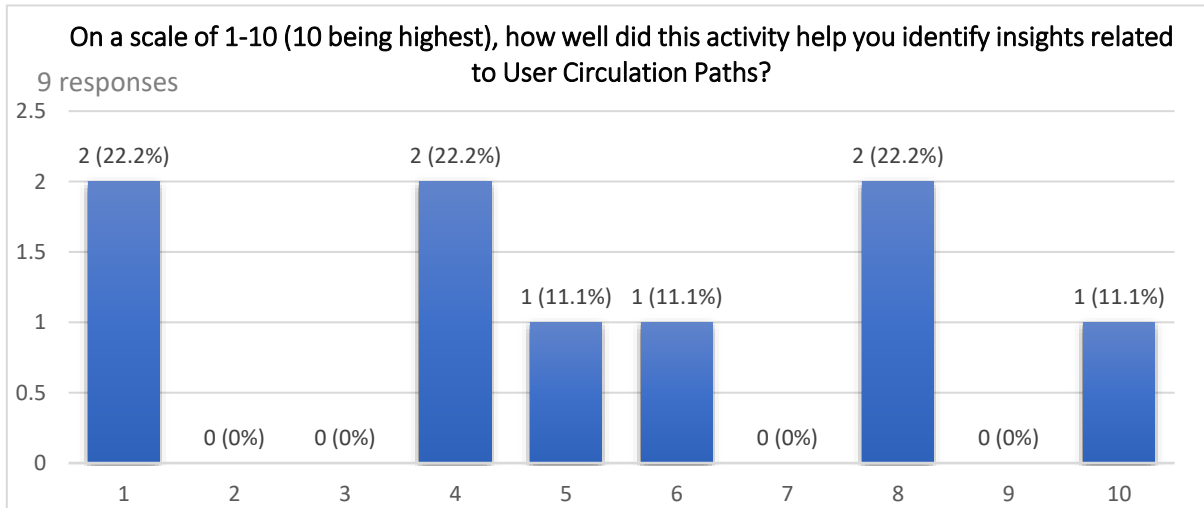


Figure 19. Value of activity 3 in gaining insights about user circulation paths and program needs.

Semantic and ambience insights. One student stated that talking with the interior designers helped them figure out the feeling of their spaces and how to effectively lead people through exhibits using atmospheric cues such as views, colors, and finishes. Another student stated that an interior designer provided insight that they should keep floor patterns to a minimum, so the planes and boats will attract the museum guests. Similarly, insight was gained that backdrops for the planes and boats could be used to direct guests' attention.

Interior design consultants also helped students' gain insights into how to create an interior ambience conducive to the maritime theme within their museums. One participant stated that the interior designers helped with a selection of interior materials that would help relate the interior ambience to the site context of Seattle to enhance the maritime theme. Interior design

consultants suggested the use of warmer and rustic colors for the museum. In addition, they provided feedback on using natural lighting and material finishes to create public and private ambiances within museum space. Figure 20 displays how well the activity helped the students gain insights related to developing semantics and ambience within their museum.

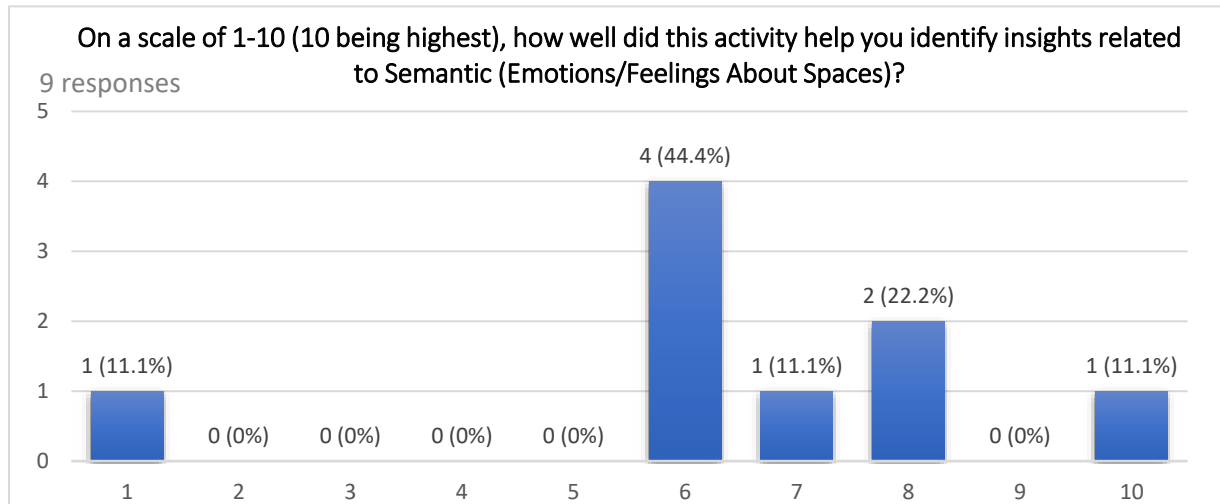


Figure 20. Value of activity 3 in gaining insights about semantics in museum spaces.

Functional needs insights. Interior design consultants suggested alternative finishes that help reduce sound levels for high activity areas in the museum. Consultants suggested wood and carpet instead of concrete floors for better sound absorption. They suggested using hard surfaces in busy spaces to scatter sound. The effect that this activity had on gaining insights related to materials and finishes is supported by Figure 21. Similarly, Figure 22 displays how well this activity helped gain insights of how to address functional needs of users.

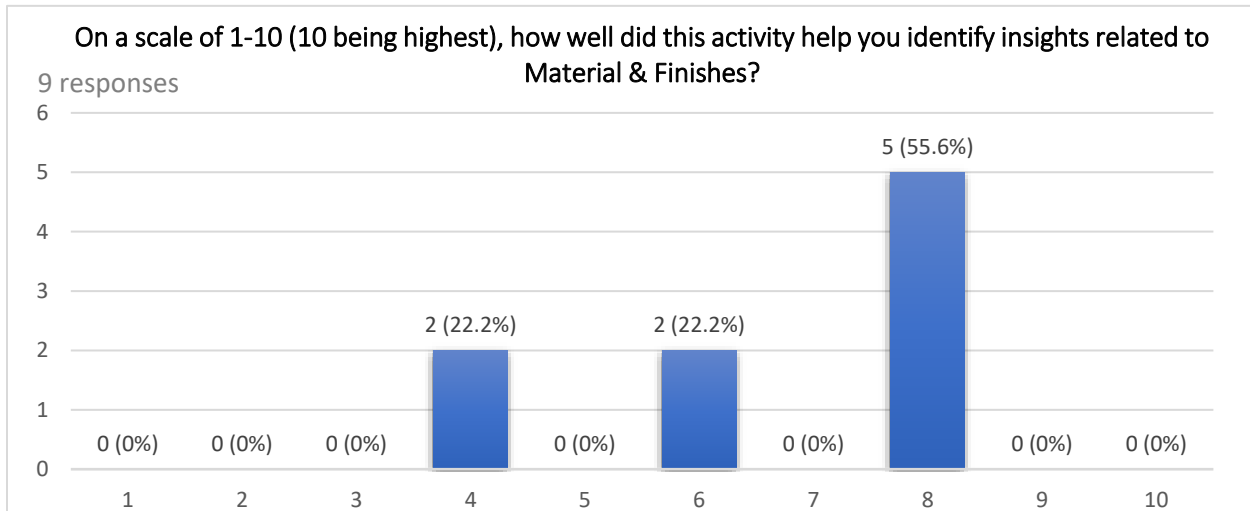


Figure 21. Value of activity 3 in gaining insights about materials and finishes.

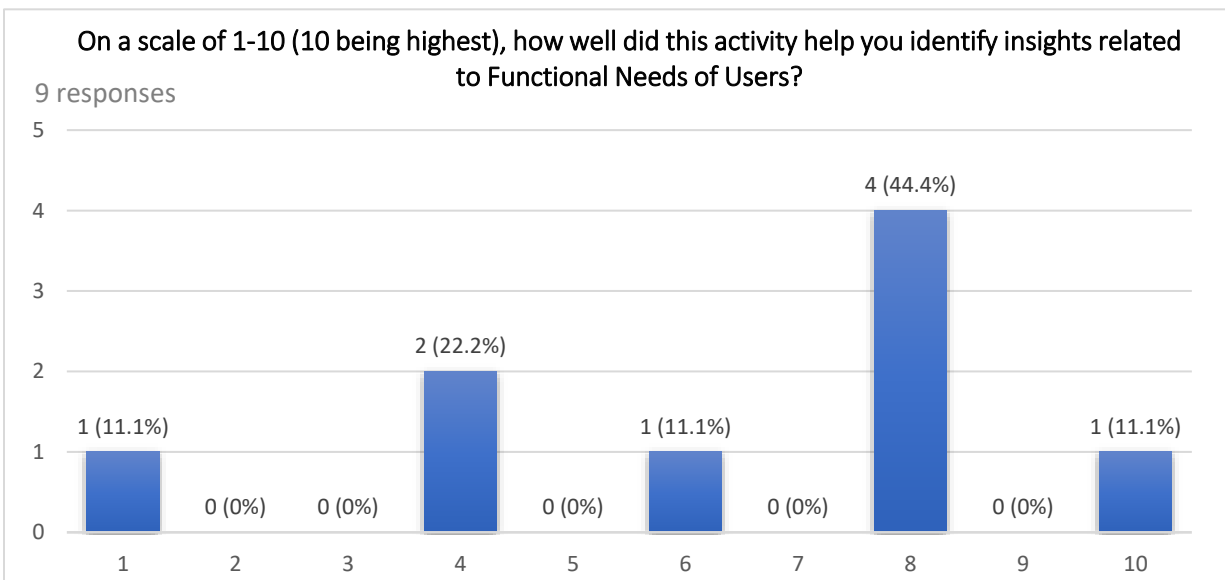


Figure 22. Value of activity 3 in gaining insights about functional needs

Building systems integration insights. Co-creating with engineering consultants in activity 3 provided insights that helped students integrate building structure and mechanical systems that responded to their design criteria and building form.

Co-creating with structural designers helped students gain insights into schematic arrangement, structural framing and understanding site constraints. Structural engineers suggested students to consistently design building cores, account for seismic activity of their site

in Seattle, and recommended that they change their structure to mass timber to accommodate seismic activity. Structural engineers helped students choose appropriate structural systems for cantilevers, design bridging skywalks between structures, and appropriately size structural elements for necessary spans and desired floor to ceiling height for large museum spaces. Figure 23 displays how well the activity helped identify insights related to structural issues.

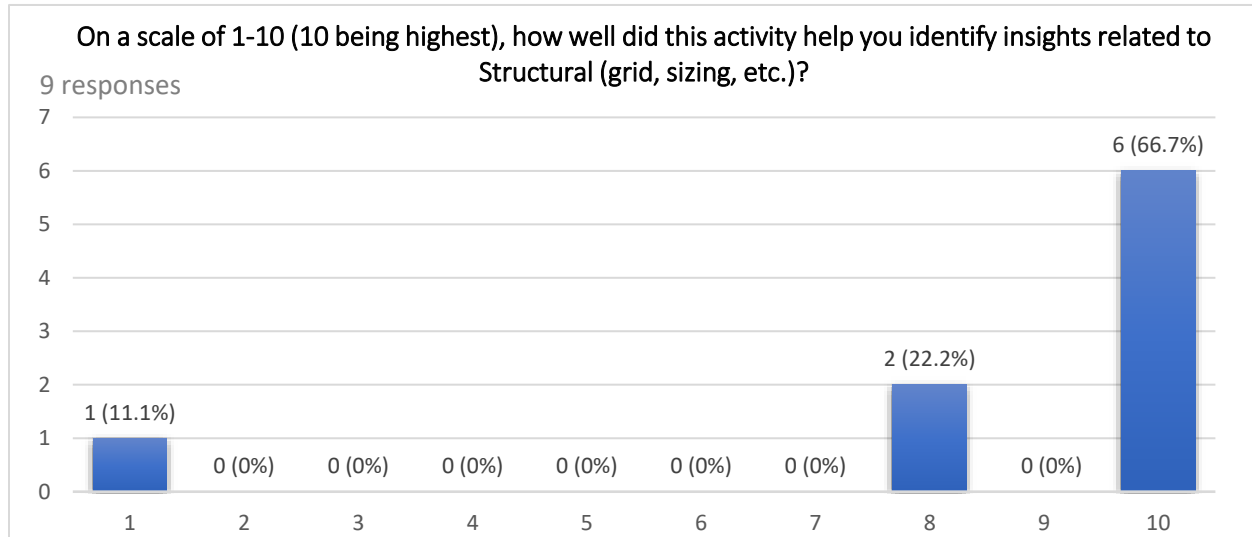


Figure 23. Value of activity 3 in gaining insights related to the structure of their museum.

Co-creating with mechanical engineers helped students gain insights into schematic arrangement and the selection and integration of an HVAC system. Mechanical engineers suggested students to schematically arrange spaces with similar environmental comfort needs closer together, consolidate program spaces with similar functions into one space, and reduce the footprint of spaces to increase efficiency of mechanical systems. Mechanical engineers helped students choose an HVAC system compatible with the form of their building, design HVAC zones, and size and locate HVAC systems within their museums. Figure 24 displays how well the activity helped identify insights related to mechanical system integration.

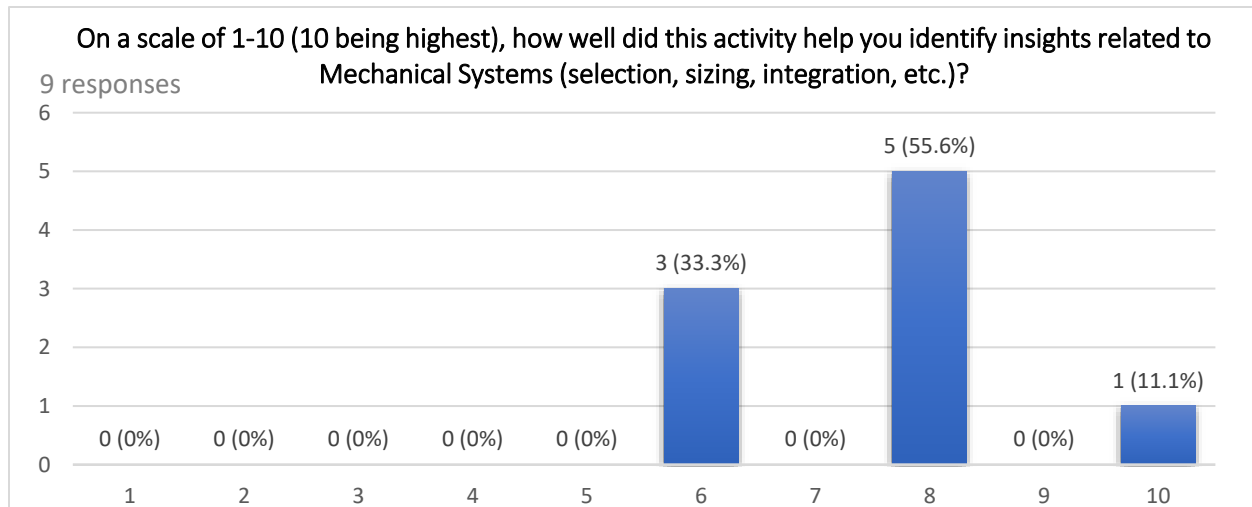


Figure 24. Value of activity 3 in gaining insights related to the integration of mechanical systems into their museum.

Summary of Findings for Activity 3

Table 3. Summary of Findings for Activity 3

Benefit of Interactive Platform	Role of Interactive Platform in Gaining Insights	Building Aspects Understood	Role of Co-Creation Insights in Assisting Learning
Enabled Student & Consultant Collaboration	Helped Generate Integrated Technical & Conceptual Solutions	<ul style="list-style-type: none"> • Program/Circulation • Semantic/Ambience • Materials/Finishes • Building Systems 	Helped Inform Holistic Design Development Across Multiple Scales

This activity provided an interactive platform that allowed students and design consultants to collaboratively build upon existing schematic design concepts and generate practical solutions to achieve stated design goals. Collaboration with professionals provided the students with technical support that they felt they normally didn't have access to in design development.

To answer the research question "How did the designers utilize and implement insights gained from co-creation?", insights gained from co-creating with consultants in activity 3 helped students to consider the technical restraints of their conceptual design solutions and address the

holistic integration of building systems, program and circulation, and ambience across multiple scales. One student stated, “After this meeting, our building actually became functional.” Examples of integrated design that were influenced from this activity included rearranging schematic plans to accommodate more intuitive guest circulation and integration of feasible HVAC and structural systems that accommodated the form of their projects. Other examples included applying interior color and material finishes that better resonate with the regional atmospheric context and accommodated acoustic needs. Figure 25 displays how helpful this co-creation was for the design development of students’ projects.

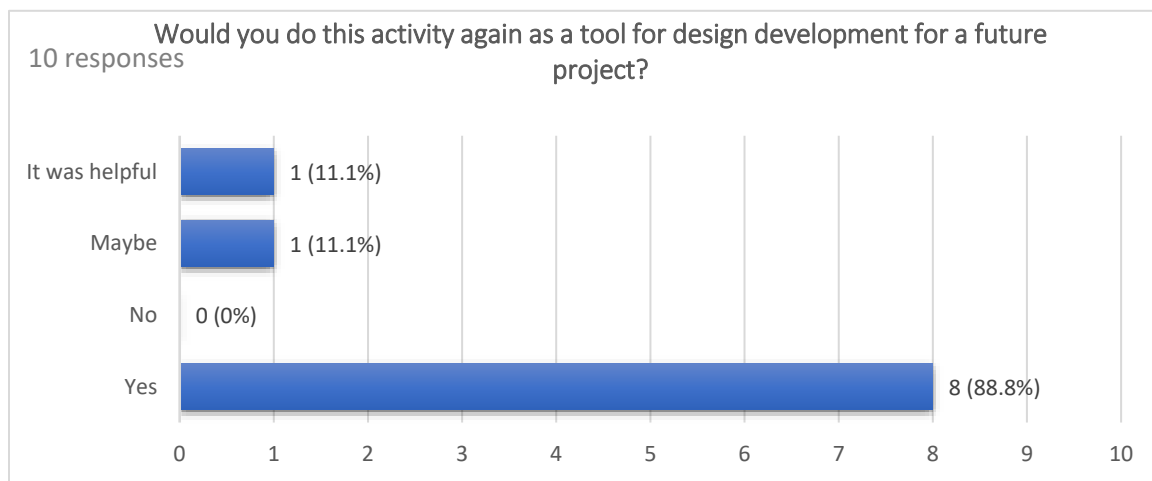


Figure 25. Student desire to use co-creation like activity 3 in the future.

Activity 4: Evaluative Co-Creation with End-Users/Experts



Activity 4 took place towards the end of the semester. The activity was scheduled a couple of days after a major design review (studio critique). Interaction with both end-users and experts of museums (curators) at this later phase of the process helped validate if students’ design solutions were aligned with both user experience needs and technical requirements of

museums. Evaluation provided students with insights and motivation to refine their designs to yield optimized user experience and museum functioning.

Enabling Evaluation of Designs Through an Interactive Platform

Traditional architecture studios typically have a last major design critique before the final critique at around the $\frac{3}{4}$ point of the semester. Although some minor edits are made to final designs based on feedback from reviewers, the last 3 to 4 weeks of the semester typically consist of students spending more time creating and making adjustments to presentation materials to ensure that their design concepts are clearly communicated. Although little refinement of details typically occurs at this point in the process, evaluation of the effectiveness and practicality of their design decisions facilitated by the interactive platform of this activity aided students in addressing such a level of detailed refinement and consideration of user experience. This section addresses the research question, “What role did the medium of co-creation play in gaining insights?”, for Activity 4.

Holistic perspectives. Students felt that bringing in diverse museum user and expert perspectives in the final stages of design helped remind them of the user experience and functionality goals of their museums and provided them with an awareness of how well their designs were meeting those goals. Students expressed that co-creation with museum curators and users provided them with different perspectives that the students could compare with the feedback from architectural reviewers. These diverse perspectives of feedback were helpful for students to comprehensively evaluate the success of their designs. For example, one student said that “the curators and users brought up good points outside of the building form.” Another said that “it was useful to hear what the users and curators wanted from the space as this is information that the reviewers couldn’t have given use because they are architects.”

While the activity helped students to better evaluate and address the details of user experience in their projects, they felt that it was complimented the architectural feedback from architectural reviewers to help them meet the learning goals of a comprehensive studio. One student commented that the architectural review and co-creation activity were complimentary because their review with architects as reviewers focused on the spaces and the architecture, while the co-creation with curators focused more on a human scale. Another stated that the activity paired well with the review because “it provided supplementary feedback to the review but didn't replace the critical feedback from a review.”

Communicating an experiential design language. Curator and user evaluation of student projects was enabled by the high quality and dimensional diversity of the presentation materials provided for this activity because they helped communicate the experience of students' museums. This understanding of experience then enabled curators and users to provide informed feedback about how the user experience could be improved. Two dimensional drawings such as floor plans and full building sections were helpful for participants to understand the building circulation.

It was also observed that 3-D drawing such as exploded axonometric drawings were helpful for the students in further explaining circulation in multiple dimensions. One participant commented that the 3-D axon they had on the plot was very helpful to “dig into the 2-D and 3-D sectional aspects of the project” as opposed to just 2-D drawings. Additionally, some students provided 3-D building models to better explain buildings holistically and felt that they were useful to quickly explain their projects and talk about certain areas.

Interior and exterior building renderings were particularly helpful in helping the curators and users experientially understand qualities and restraints of spaces. Curator and user feedback

concerning semantic and functional qualities, such as interior lighting conditions and ugly views, suggests that renderings provided an authentic understanding of space.

It was observed that the curators drew over a diversity of different drawings to explore and describe their ideas to students in multiple dimensions. For example, they would reference a circulation path in plan, then in section, and then point to that path in an interior rendering.

Evaluation of User Experience and Functionality

The section addresses the research question, “What is the role of co-creation in gaining insights for an architecture design project?” The most important outcome from this activity was that it helped students to gain insights about how to improve the user experience for guests and how to improve the functionality of museum designs so that they helped employees to do their jobs efficiently.

Program and circulation evaluations. Co-creating with end-users and curators helped students (internal participants) gain verification and insights to refine the circulation of museums to be more intuitive for guests, and to be more efficient for employees and back of house operations.

Intuitive Guest Circulation. Both users and curators provided evaluations centered around intuitive wayfinding for museum guests. End-users representing museum employees suggested landscaping options to increase use of exterior circulation paths. Once inside the building, end-users representing guests suggested solutions to resolve circulation paths throughout the building with multiple entry points and to arrange lobby circulation to increase gift shop. Additionally, curators suggested solutions to improve wayfinding through exhibits with more optimal layouts.

Efficient employee circulation. Curators were particularly helpful at providing insights into how museums actually worked (behind the scenes) and how changing small details could enhance efficient maintenance and administrative operations. For instance, they suggested solutions of how to size and relocate exhibit storage areas to maximize efficiency of circulation routes for employees transferring artifacts between storage and exhibit spaces. Figure 26 displays how well the activity helped identify insights related to program and user circulation paths.

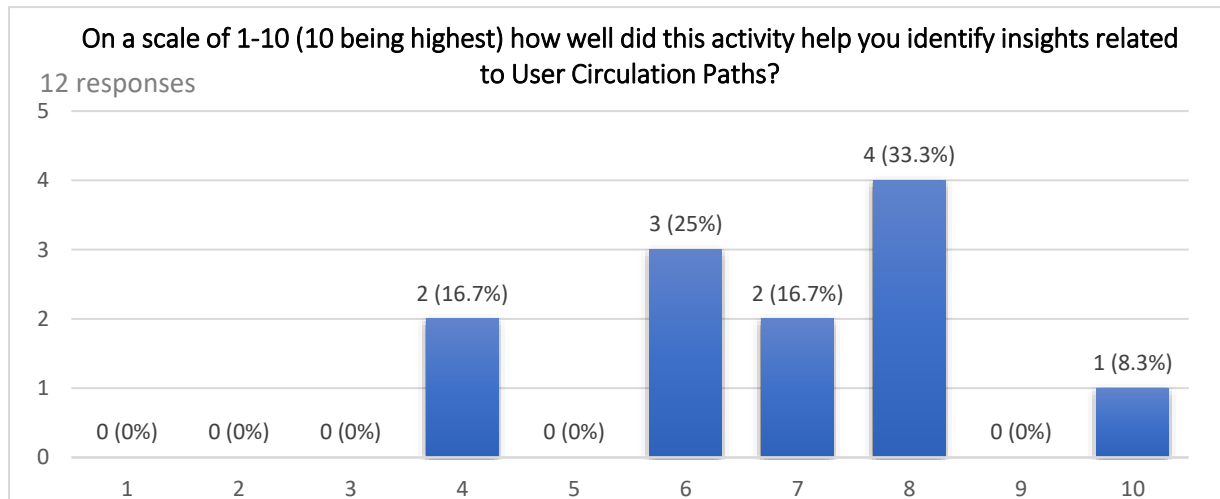


Figure 26. Value of activity 4 in gaining insights about circulation paths and program.

Semantic and ambience evaluations. Co-creating with end-users and curators helped students (internal participants) refine the semantic and ambience of interior spaces to be more aesthetically enjoyable. End-users pointed out elements, such as ugly views, that distracted and diminished the impact of spaces. Curators then provided insights that helped refine a guided experience through exhibition levels by suggesting how to create “ah ha” moments by helping them frame views. Figure 27 displays how well the activity helped identify insights related to refining semantic and ambience.

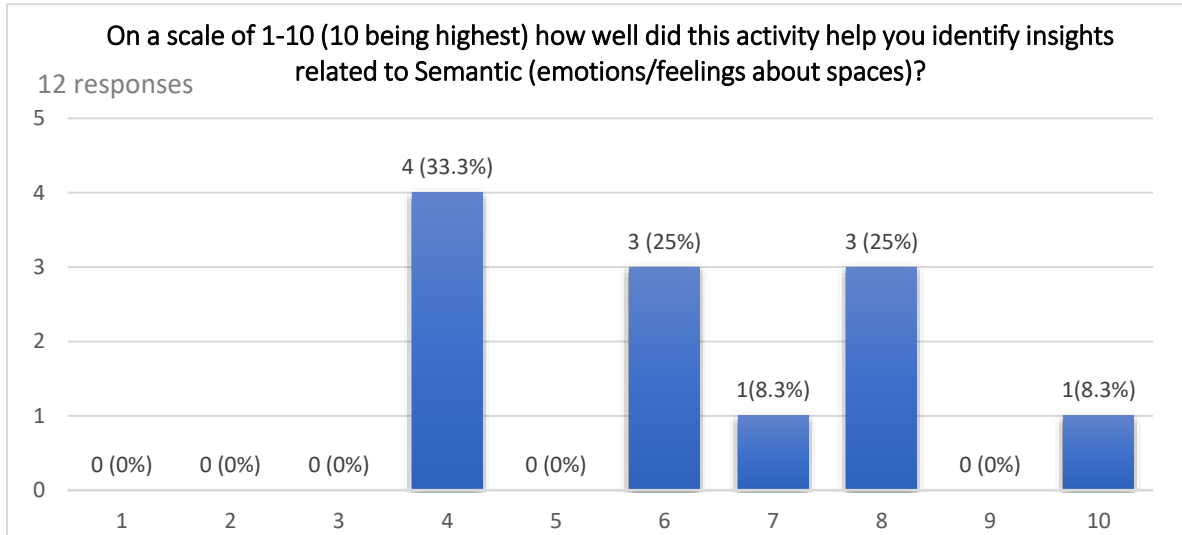


Figure 27. Value of activity 4 in gaining insights about semantics in museum spaces.

Functionality evaluations. Co-creating with curators also provided students with insights into how to enhance functionality of museums to provide enhanced comfort, protection, and flexibility.

Exhibit functionality. Curators provided students with insights into furniture and lighting design to enhance the functionality of their exhibit spaces. They suggested students to provide resting spaces in between exhibit spaces to allow guests to decompress and maintain their attention. They also suggested the use of adjustable wall panels to maximize the flexibility and modularity of diverse exhibit content over time. Other exhibit related insights included suggested use of specific furniture to prevent children from climbing on exhibit pieces. Figure 28 displays how well the activity helped identify insights related to exhibit design.

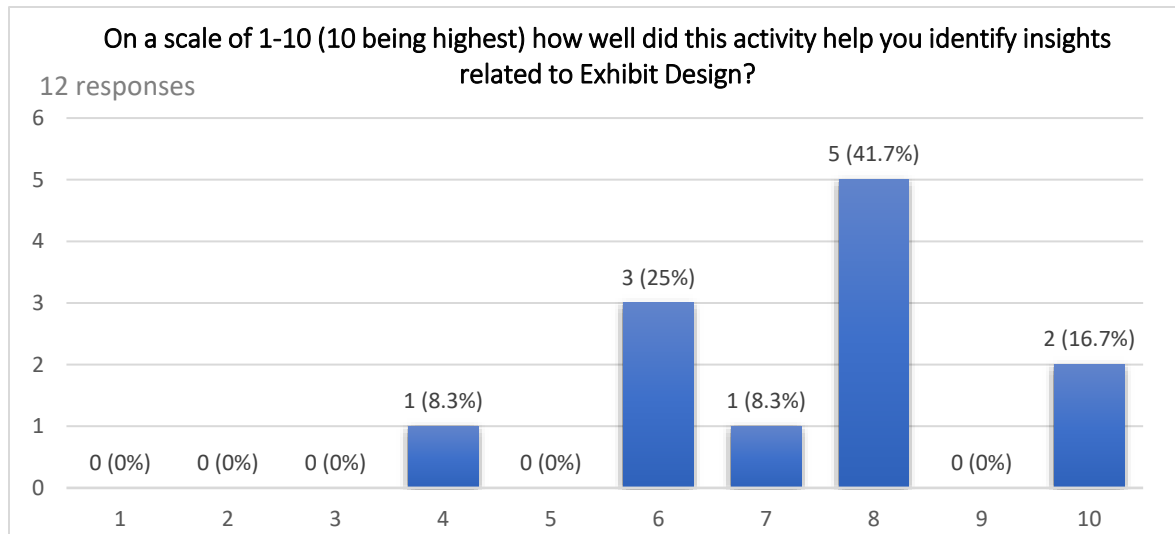


Figure 28. Value of activity 4 in gaining insights related to exhibit design

User comfort. Curators and users also shared their experiences and tips of how to deal with natural light to maximize user comfort and protect light sensitive artifacts. A photography consultant and curators suggested that students control natural light into museum spaces by adding louver systems and using UV protective glass to reduce glare. End-users also provided solutions to glare in libraries by suggesting that library and reading rooms could become digital. Figure 29 displays how well the activity helped identify insights related to lighting. Overall, Figure 30 shows how well Activity 4 helped identify insights to address functional needs.

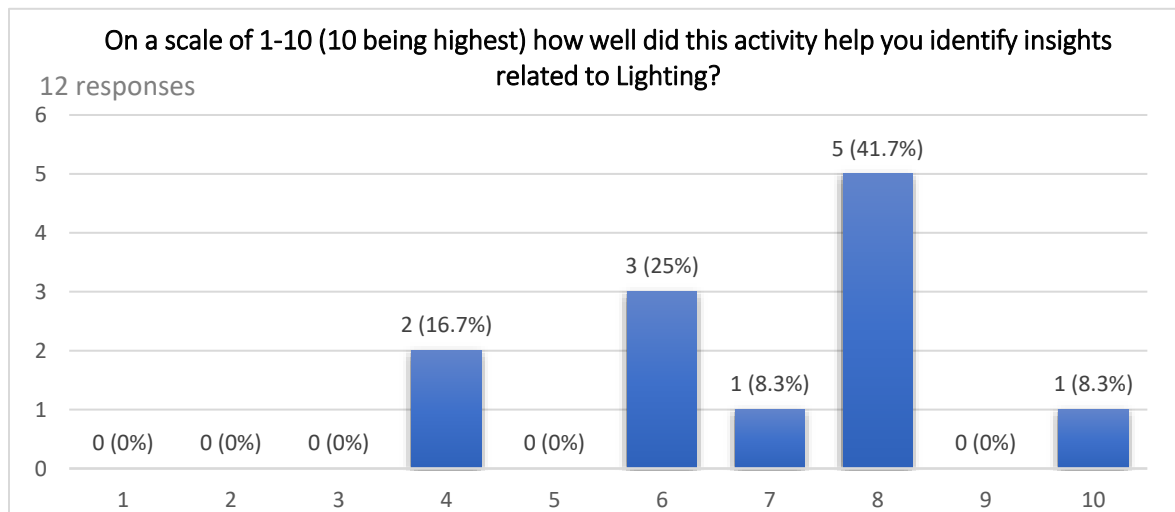


Figure 29. Value of activity 4 in gaining insights related to lighting

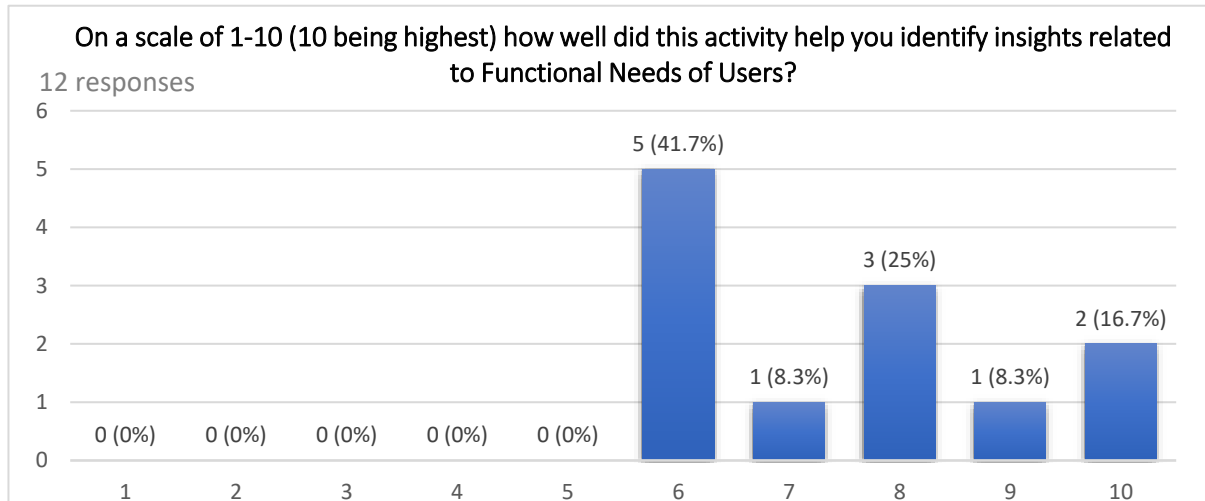


Figure 30. Value of activity 4 in gaining insights related to functional needs of users

Summary of Findings for Activity 4

Table 4. Summary of Findings for Activity 4

Benefit of Interactive Platform	Role of Interactive Platform in Gaining Insights	Building Aspects Understood	Role of Co-Creation Insights in Assisting Learning
Communicated an Experiential Understanding of Student Designs	Helped Evaluate User Experience of Integrated Solutions	<ul style="list-style-type: none"> • Program/Circulation • Semantic/Ambience • Functionality 	Influenced Refinement of Design Solutions to Optimize User Experience

This activity provided an interactive platform that allowed students, end-users, and curators to evaluate whether integrated design solutions still met user needs after going through transformations in design development. Insights gained from users and curators influenced students to make final refinements to their designs to optimize the user experience and functionality of their museums.

Refinement of user experience and functionality. This section addresses the research question, “how did the designers utilize and implement insights gained from co-creation?”, specific to activity #4. Insights gained from evaluative co-creation with users and consultants helped students to address detailed scales of refinement that they normally wouldn’t have

bothered with in the final stages of the process. Refinements to improve program and circulation included making landscaping changes, adjusting gallery layout and lighting to improve wayfinding, and adjusting storage locations and sizes to make back of house and maintenance operations more efficient. Semantic refinements included adjusting window locations to improve views. Refinements to improve the functionality of projects included adjusting window types and screens to control glare and UV light, integrating movable partition walls to provide flexibility, and adding security thresholds for exhibit pieces.

Students noted that it was because of the straight forward solutions and confidence they had in user's and professional's expertise that motivated them to make refinements. One student said that "without having these little hints of realism from professionals given to us, we probably wouldn't have considered this scale of refinement because we would get too busy". Another stated that "it was also nice to talk to professionals in the field because you get quick solutions that you can add that you have no doubts about because this is how professionals do it". Figure 31 displays how helpful co-creating with users and specialty consultants was for the final phases of design development of students' projects.

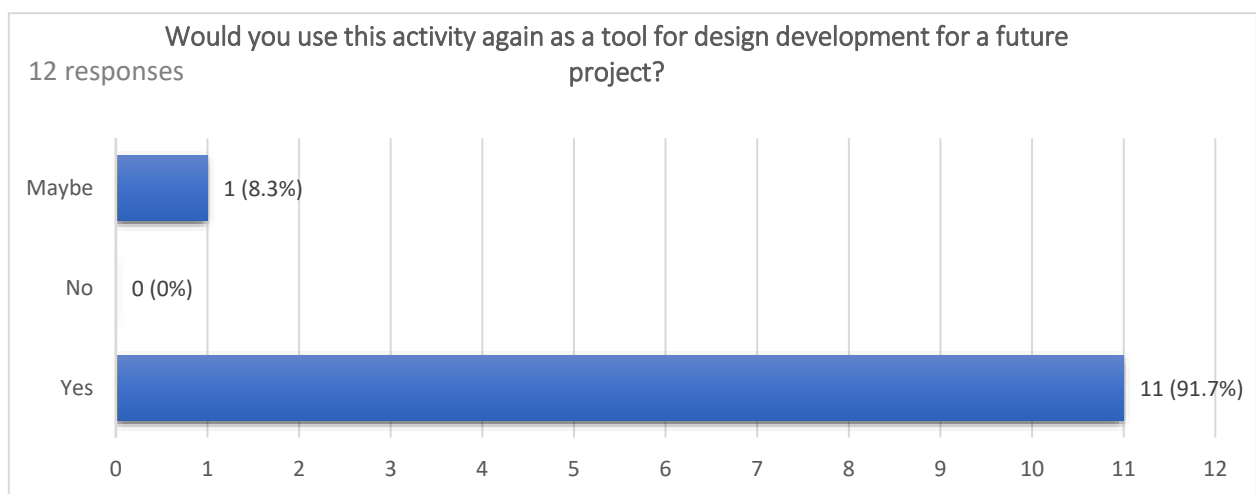


Figure 21. How helpful activity 4 was as a tool for design development in the final phases of design.

CHAPTER 5. CONCLUSION & DISCUSSION

Overview

This chapter discusses the value that co-creation with diverse stakeholders at 3 key points had in helping students discover insights for comprehensive project development. It also discusses how the study contributes to a growing number of alternative approaches to architecture studio pedagogy aimed at helping students evaluate and integrate design solutions based on a diversity of realistic constraints. The following sections summarize the findings to the following research questions:

1. What is the role of co-creation in gaining insights for an architecture design project?
2. What role did the medium of co-creation play in gaining insights?
3. How did the designers utilize and implement insights gained from co-creation?

Benefits of an Interactive Platform

This section addresses the research question:

- What is the role of co-creation in gaining insights for an architecture design project?

In traditional architecture studios, students typically gain insights to inform development of their projects based on feedback from instructors and reviewers with architectural expertise in the form of a critique. This method of knowledge delivery in architectural studios has been critiqued by literature for limiting student creativity and exploration in studios to please the perceived tacit desires of the architectural instructors and reviewers (Ardington & Drury, 2017). New approaches to studio pedagogy, such as design-build, have focused on providing students with exposure to diverse stakeholder perspectives with expertise other than architecture to gain insights that help guide integrated design development and development of critical thinking skills based on realistic constraints.

This study documents a structured methodology to facilitate productive participation of diverse stakeholders throughout an integrated architecture studio. An integrated studio is one where students research, evaluate and implement integrated comprehensive aspects of design across multiple scales. Co-creation helped students gain meaningful insights from diverse stakeholders by providing them with an interactive platform to collaborate. Students expressed collaborating with stakeholders to be productive and asking multiple questions without fear of embarrassment. They also expressed that collaboration with professionals and users provided them with straightforward and credible information that they normally don't have access to. What enabled this productive collaboration with stakeholders that differed from typical design critiques is the media that facilitated creativity and communication between the stakeholders and students.

A Common Language for Creativity

This section addresses the research question:

- What role did the medium of co-creation play in gaining insights?

Tangible props provided for the co-creation activities that enabled stakeholders to express their creativity and take part in the process to communicate tacit and latent user needs. What was particularly helpful was the multi-dimensionality of these props that enhanced a visualization of space and experience. This visualization created a mutual language of spatial literacy between the designers and stakeholders, which allowed the stakeholders to develop their own opinions and provide informed feedback.

The easily modifiable nature of the props was another key factor that supported participation and encouraged creative ideas. Materials such as pre-cut cardboard shapes provided a sense of scale and context to initiate exploration of ideas and solutions. They could then easily

explore diverse solutions by ripping, tearing, and drawing over these initial constraints. The combination of being able to easily visualize spatial outcomes, along with being able to easily change and modify the props, enabled stakeholders to experiment with different ideas until they arrived at solutions that expressed the ideas they wanted to communicate to the students. The physical nature of this thought process resulted in visual documentation of stakeholder ideas that helped students to understand and gain insights that may be harder to grasp through purely verbal interactions.

Assisted Development of Integrated Design

This section addresses the research question:

- How did the designers utilize and implement insights gained from co-creation?

The insights gained from the co-creation activities with external stakeholders were utilized by students to develop their studio projects in a comprehensive fashion. Their utilization of co-creation insights helped them address the learning goals of a comprehensive integrated studio.

Integration of Research-Based Rigor for Evaluation of Design Criteria and Development

One of the learning objectives for an integrated architecture studio is that students should show an integration of research-based rigor in their design development process (National Architectural Accrediting Board, 2014). While students still relied upon the traditional use of architectural precedent studies research to inform decisions, co-creation also provided them with a new form of primary user research with users and consultants.

Activity 2 provided students with a platform to research user needs. Insights from this research were utilized by students to develop informed design criteria that helped guide the development of their projects. Interaction with museum users generated empathy for user needs that encouraged them to evaluate whether solutions met user design criteria. Insights from

Activities 3 and 4 provided students with further research insights to help develop and evaluate their design solutions across multiple scales simultaneously.

Holistic Integration of Technical Building Systems and Realistic Constraints

Another major learning objective for integrated architecture studios is that students should accurately represent and critically integrate a broad range of technical requirements and building systems that support and enhance design choices for building performance and experience (National Architectural Accrediting Board, 2014). Co-creating with design consultants in Activity 3 helped students to realize the technical constraints of their conceptual schematic designs and understand a range of practical technical solutions that could be integrated to support their conceptual goals and design criteria. Collaborating with professionals at this early stage of design development was key in reminding the students to consider the integration of feasible building systems when making conceptual decisions about form. Students utilized insights and specific recommendations from consultant collaboration to integrate structural and mechanical systems that were compatible with their design criteria for efficient building performance, aesthetics, circulation, comfort, and user experience. Co-creation with consultants at the point of conceptual decision making helped students develop realistic and practically feasible projects.

Evaluation and Refinement of User Experience

The learning objectives for an integrated architecture studio also state that students must demonstrate integrated decision making across multiple scales and variables in a project by analyzing solutions and predicting the effectiveness of implementation (National Architectural Accrediting Board, 2014). Co-creating with museum users and curators towards the end of the project was beneficial to bring the conversation back to user experience to help students evaluate

how well their design outcomes were meeting design criteria for user needs including intuitive guest circulation, semantic effectiveness, and programing for efficient employee operations. The students then made refinements to their projects that they predicted would optimize the user experience and functionality of their museums based on the confidence they had in the user's and curator's expertise of recommendations.



Table 5. Role of co-creation activities in assisting development of integrated design in an architecture studio

	Benefit of Interactive Platform	Role of Interactive Platform in Gaining Insights	Building Aspects Understood	Role of Co-Creation Insights in Assisting Learning
Activity 2: Co-Creation with Users	Enabled Users to Express Creativity	Helped Discover User Needs	<ul style="list-style-type: none"> • Program/Circulation • Semantic/Ambience • Functional Needs 	Helped Develop Informed Design Criteria
Activity 3: Co-creation with Consultants	Enabled Student & Consultant Collaboration	Helped Generate Integrated Technical & Conceptual Solutions	<ul style="list-style-type: none"> • Program/Circulation • Semantic/Ambience • Materials/Finishes • Building Systems 	Helped Inform Holistic Design Development Across Multiple Scales
Activity 4: Evaluative Co-creation with Users/Experts	Communicated an Experiential Understanding of Student Designs	Helped Evaluate User Experience of Integrated Solutions	<ul style="list-style-type: none"> • Program/Circulation • Semantic/Ambience Functionality 	Influenced Refinement of Design Solutions to Optimize User Experience

Overall, these activities assisted students in developing integrated design solutions by helping them to evaluate and develop design solutions from multiple perspectives of experience

and practicality. This helped them to produce comprehensive and realistic integrated design outcomes that addressed an optimized user experience as well as effective integration of practical building systems and technical details that achieved this experience. The implementation of these co-creation activities at 3 key moments throughout the semester of the studio provides an example of a structured methodology for implementing participatory co-creation into an architecture studio pedagogy. The following table summarizes the benefits that each activity had in assisting students to develop integrated and comprehensive projects throughout a comprehensive integrated architecture studio.

Implications for Architecture Pedagogy

Findings from this study suggest that the implementation of co-creation in architecture studios could have positive implications for assisting student learning of how to comprehensively integrate complex aspects and perspectives of architectural design into a creative and realistic building design. According to Dutton (1987), studios are an integral part of architectural design pedagogy and should help students learn design skills through hands on engagement in analytic, synthetic, and evaluative modes of thinking. Findings from this study suggest that participatory co-creation promotes all three modes of thinking for students in an architecture studio.

Participatory design methods can provide viable methodological alternatives for understanding needs of future users. Analytically, the integration of these co-creation methods into architecture studio pedagogy could help students develop methods of primary design research to widen their scope of inquiry methods past secondary research such as case studies. Synthetically, the collaborative nature of these co-creation activities shows the potential to collectively brainstorm wider range of ideas. Interaction with users and design consultants throughout the design process also shows potential to help students discover and analyze realistic needs and constraints,

synthesize those needs into design criteria, generate high impact ideas, and evaluate design decisions based on informed reasoning.

Alternative approaches to studio pedagogy have provided students with tools and methods intended to provide insights that drive integrated design development from the perspectives of material innovation, sustainability, and cost analysis. This study adds to this toolset of approaches aimed at providing more comprehensive integrated thinking by providing a methodology to help students integrate a cultural awareness of user needs into their decision-making process. Exposure to co-creation methods to integrate consideration of user needs and consultant collaboration throughout the design process may help provide students with skills needed to balance real world constraints in professional practice and the desire to design human-centered buildings. None of the internal participants in this project had previous exposure to co-creation activities before this studio. At the end of the studio, a majority of the students expressed that the co-creation methods helped them design with an empathetic mindset and that they would continue to use co-creation in future projects. One participant stated that it would be a useful tool to “actually build what people want instead of building what I think is right.” Others expressed that co-creation could help make projects more meaningful to users by involving them in the process.

Future Research

In future studies of co-creation conducted with academic architectural studios, external participants could be screened to identify the level of value and authenticity they will add to co-creation sessions. This study could also be re-conducted with a sponsored architectural studio designing a real-world project with access to professional consultants and potential end-users of the project to study the effect that real-world constraints would have on design outcomes and the

extent to which design outcomes align with user needs. Future research could also focus on the development of the co-creation props and methodology. Studies should also focus on the development of methods to help students analyze and evaluate insights gained from co-creation.

As this participatory methodology was helpful for students to design outcomes that aligned with user needs, future research could study if participatory co-creation would be an effective tool to discover and design for user needs in a professional practice context. First steps towards this research could address how to best teach professionals to conduct co-creation activities with users. Studies should also address the feasibility of co-creation in a professional setting and how the methodology proposed in this study can be altered to adapt to real-life constraints of professional practice. Studies of co-creation a professional setting should also be done in conjunction with post-occupancy studies to evaluate the effect that co-creation with a diversity of users throughout the process may have on the extent to which design outcomes align with the needs of a comprehensive diversity of end-users.

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APPENDIX A. ACTIVITY 1 INTERNAL PARTICIPANT POST-ACTIVITY
QUESTIONNAIRE

Co-Creation in Architecture

Activity 1 Questionnaire

Name: _____

1.) Have you tried Co-Creation before today?

2.) Was this training session in Co-Creation efficient / intuitive? Did you learn?
(Please circle and reply with 5 being the highest and 1 being the lowest)

1 5

4.) On a scale of 1-5 (1 being the lowest and 5 being the highest), how.....

Engaging was this activity?

1 5

Enjoyable was this activity?

1 5

Informative / Insightful was this activity?

1 5

5.) Please list 3 benefits you see of doing this activity:

6.) Please list 3 limitations/challenges of this study:

7.) On a scale of 1-5 (1 being the least and 5 being the most confident), how confident do you think you are to be able to conduct this activity by yourself?

1 5

a.) Would you need more help to become more confident leading it by yourself such as printed instructions/ cheat sheets? Another training session?

Please flip page over to complete comparison of 2D and 3D Activities

7.) Please compare the 3D and 2D versions of the activity

2D Activity

PROS

CONS

3D Activity

PROS

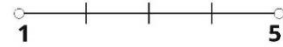
CONS

APPENDIX B. ACTIVITY 2 INTERNAL PARTICIPANT POST-ACTIVITY QUESTIONNAIRE

Co-Creation in Architecture Activity 2 Questionnaire

Name: _____

1.) On a scale of 1-5 (1 being the lowest and 5 being the highest), how well did this activity help you understand **user needs**?



2.) On a scale of 1-5 (1 being not helpful and 5 being very helpful), how much do you think the **insights** you learned today will help you develop **design criteria** for your own project?

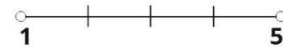


4.) On a scale of 1-5 (1 being the lowest and 5 being the highest), how well did this activity help you identify insights related to the following:

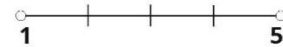
User Circulation Paths



Semantic (emotions/feelings about spaces)



Functional Needs of Users



5.) Please list 3 insights that you learned from your users in this activity.

6.) Was this activity easier and more helpful with the actual users than it was when you did it with your classmates?

7.) Would you do this activity again as a tool for a future project?

(Yes / No / Maybe)

APPENDIX C. ACTIVITY 3 INTERNAL PARTICIPANT POST-ACTIVITY QUESTIONNAIRE

Co-Creation in Architecture Activity 3 Questionnaire

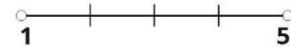
Name: _____

1.) Who did you co create with in each session (please circle all that apply)?

Session 1: Mechanical Engineer / Structural Engineer / Building Science and Material Expert / Interior Designer / Curation Consultant / Other

Session 2: Mechanical Engineer / Structural Engineer / Building Science and Material Expert / Interior Designer / Curation Consultant / Other

2.) On a scale of 1-5 (1 being not helpful and 5 being very helpful), how much do you think the **insights** you learned today will help you develop your project?

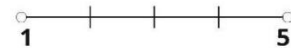


3.) On a scale of 1-5 (1 being the lowest and 5 being the highest), how well did this activity help you identify insights related to the following:

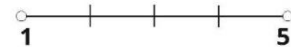
User Circulation Paths



Semantic (emotions/feelings about spaces)



Functional Needs of Users



Structural (grid, sizing, etc.)



Mechanical Systems (selection, sizing, integration, etc.)



Materials & Finishes



4.) Please list 3 insights you learned from your co-creation activities with each group of consultants related to the categories below:

Mechanical & Structural Design/Integration	Materials & Finishes
1.	1.
2.	2.
3.	3.

5.) Would you do this activity again as a tool for design development for a future project?

(Yes / No / Maybe)

APPENDIX D. ACTIVITY 4 INTERNAL PARTICIPANT POST-ACTIVITY QUESTIONNAIRE

Co-Creation in Architecture Activity 4 Questionnaire

Name: _____

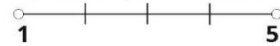
1.) Who did you co-create with in each session (please circle all that apply)?

Session 1: Curator(s) / Museum Employee User(s) / Museum Guest Users(s)

Session 2: Curator(s) / Museum Employee User(s) / Museum Guest Users(s)

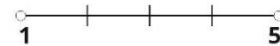
Session 3: Curator(s) / Museum Employee User(s) / Museum Guest Users(s)

2.) On a scale of 1-5 (1 being not helpful and 5 being very helpful), how much do you think the **insights** you learned today will help you develop your project?



3.) On a scale of 1-5 (1 being the lowest and 5 being the highest), how well did this activity help you identify insights related to the following:

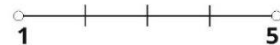
Exhibit Design



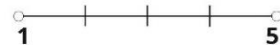
User Circulation Paths



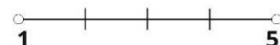
Semantic (emotions/feelings about spaces)



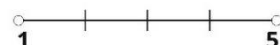
Functional Needs of Users



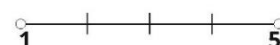
Lighting



Furniture Arrangement



Materials & Finishes



Other Aspects (please specify)



4.) Please list 3 insights you learned from your co-creation activities with each group of museum guests, museum employees, or museum curators

Curators	Average Users (employees, guests)
1.	1.
2.	2.
3.	3.

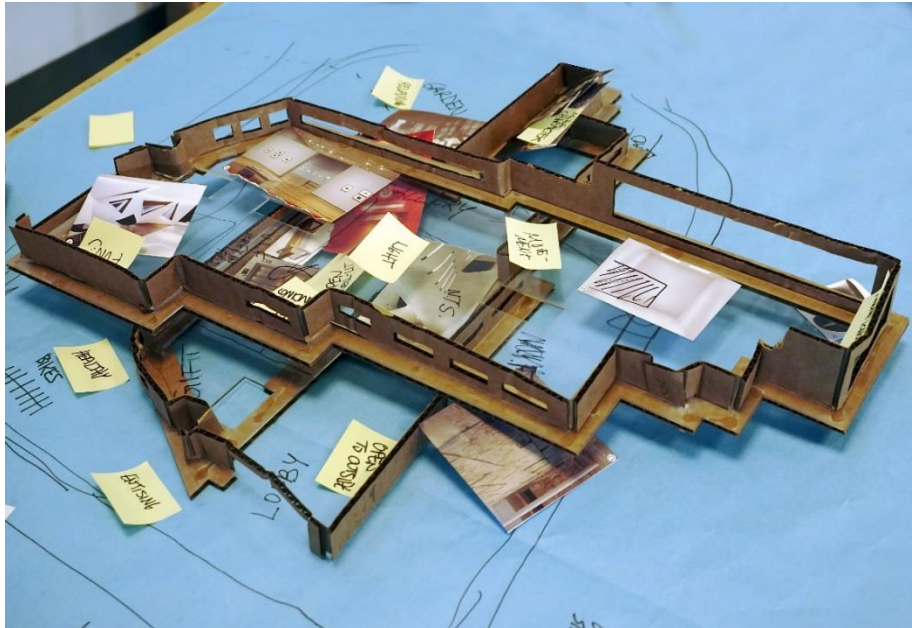
5.) Would you do this activity again as a tool for design development for a future project?

(Yes / No / Maybe)

6.) Do you feel that this activity would have been more useful sooner, now, or later?

(Sooner / Now / later)

APPENDIX E. PHOTOS FROM ACTIVITY 1



3-D interface showing adjectives and images placed and showing site context drawn around model.



2-D interface: arranging spaces

APPENDIX F. PHOTOS FROM ACTIVITY 2



Step 1: Arranging Spaces

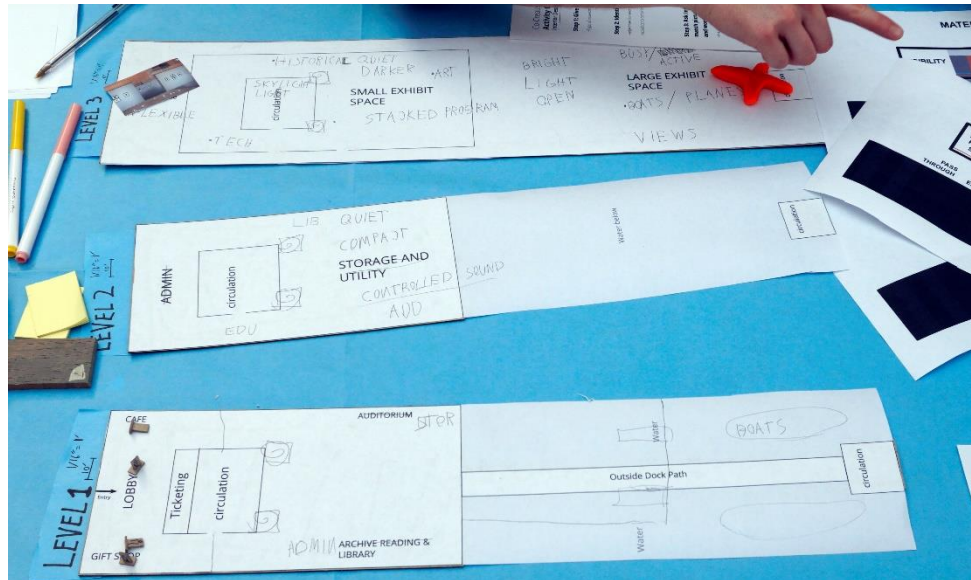


Step 2: Placing Adjectives



Step 3: Placing Semantic Images and Furniture

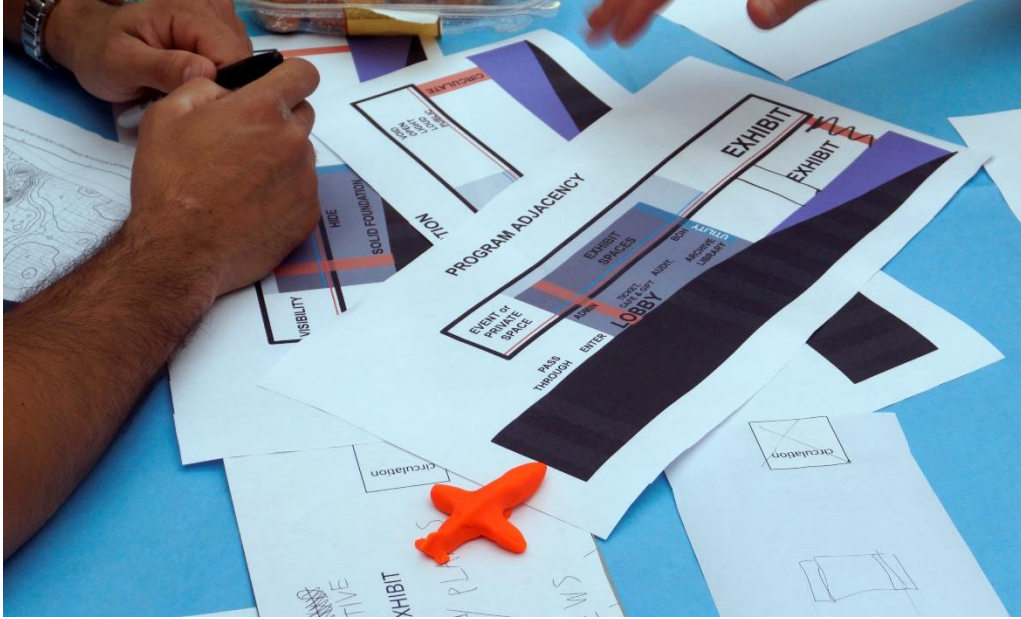
APPENDIX G. PHOTOS FROM ACTIVITY 3



Students describing spaces and design criteria by writing adjectives on schematic plans



Consultants drawing ideas on schematic plans



2-D sections and Playdough being used by consultants to provide scale and context for feedback



Drawing, images, and materials used to brainstorm a new schematic plan

APPENDIX H. PHOTOS FROM ACTIVITY 4



Exploded axon drawings used to help external participants visualize design



Physical models used by some students to help external participants visualize design

APPENDIX I. IRB APPROVAL MEMO

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Institutional Review Board
Office for Responsible Research
Vice President for Research
3420 Lincoln Way, Suite 202
Ames, Iowa 50014
515 294-4566

Date: 9/5/2017

To: Brad Wicks
320 Hillcrest Ave, Unit 22
Ames, IA 50014

CC: Dr. Tejas Dhadphale
146 College of Design
Rob Whitehead
146 College of Design

From: Office for Responsible Research

Title: Co-Creation in Architecture

IRB ID: 17-354

Approval Date: 9/5/2017

Date for Continuing Review: 9/4/2019

Submission Type: New

Review Type: Expedited

The project referenced above has received approval from the Institutional Review Board (IRB) at Iowa State University according to the dates shown above. Please refer to the IRB ID number shown above in all correspondence regarding this study.

To ensure compliance with federal regulations (45 CFR 46 & 21 CFR 56), please be sure to:

- **Use only the approved study materials** in your research, including the recruitment materials and informed consent documents that have the IRB approval stamp.
- **Retain signed informed consent documents for 3 years after the close of the study**, when documented consent is required.
- **Obtain IRB approval prior to implementing any changes** to the study by submitting a Modification Form for Non-Exempt Research or Amendment for Personnel Changes form, as necessary.
- **Immediately inform the IRB of (1) all serious and/or unexpected adverse experiences** involving risks to subjects or others; and (2) **any other unanticipated problems involving risks** to subjects or others.
- **Stop all research activity if IRB approval lapses**, unless continuation is necessary to prevent harm to research participants. Research activity can resume once IRB approval is reestablished.
- **Complete a new continuing review form** at least three to four weeks prior to the **date for continuing review** as noted above to provide sufficient time for the IRB to review and approve continuation of the study. We will send a courtesy reminder as this date approaches.

Please be aware that IRB approval means that you have met the requirements of federal regulations and ISU policies governing human subjects research. **Approval from other entities may also be needed.** For example, access to data from private records (e.g. student, medical, or employment records, etc.) that are protected by FERPA, HIPAA, or other confidentiality policies requires permission from the holders of those records. Similarly, for research conducted in institutions other than ISU (e.g., schools, other colleges or universities, medical facilities, companies, etc.), investigators must obtain permission from the institution(s) as required by their policies. **IRB approval in no way implies or guarantees that permission from these other entities will be granted.**

Upon completion of the project, please submit a Project Closure Form to the Office for Responsible Research, 202 Kingland, to officially close the project.

Please don't hesitate to contact us if you have questions or concerns at 515-294-4566 or IRB@iastate.edu.